SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1904.

GENERAL PHYSICS.

951. *A Modified Volumenometer, and a Weight Volumenometer.* **G. Guglielmo.** (N. Cimento, 6. pp. 371–376, Nov. and Dec., 1903.)—The first instrument described is similar in principle and method of use to the stereometer of Say, but is stated to be more exact. It consists of a cylindrical funnel communicating, by a short capillary tube, with an inverted pear-shaped bulb, to the end of which is attached a long thick-walled glass tube graduated downwards from the cylindrical part of the bulb. The funnel has finely polished edges, and is closed with a smooth glass plate, the whole apparatus being supported in a deep mercury trough by strings which serve to adjust the depth of the tube immersed, and thus the pressure and volume enclosed. The *Weight Volumenometer* is a modification of the preceding, a cock being attached to the bottom, with a short capillary exit tube graduated in cubic mm., while the mercury trough is replaced by a small tared basin, into which mercury is caused to overflow. It is then weighed, thus measuring the increase in volume of air enclosed by the instrument. W. H. Si.

952. *Torsional Vibrations and Moduli of Elasticity.* **F. A. Schulze.** (Ann. d. Physik, 13. 3. pp. 583–594, Feb., 1904. Physik. Institut der Universität, Marburg.)—Deals more especially with the torsional vibrations of thin rods of *rectangular* section. The different formulæ due to Saint-Vénant are quoted and applied. Experiments were made with rods of steel, brass, bismuth, glass, and ebonite of about 10 mm. wide and from 1–2 mm. thick. The value of Young's Modulus and the Modulus of Simple Rigidity are deduced from observations of the time of vibration of the torsional and transverse vibrations of the rods fixed at one end. The values obtained correspond fairly well with those obtained by observers using other methods. W. W. H. G.

953. *Surface Tension.* **N. E. Dorsey.** (Science, 17. pp. 868–870, May 29, 1903.)—The author states the surface-tension equation of Laplace in the form $\frac{M^2T}{D^2} = I\frac{m^2}{k}$, where M is the molecular weight of the liquid, T the surface tension, D the density, *k* the constant of the elemental force equation, I the integral in that equation, and *m* a factor of proportionality depending upon

the nature of the molecule. He then assumes for *k* the values of the sp. inductive capacity (going upon an electric hypothesis of molecular forces), and finds values for *m* for various liquids, all of the same order of magnitude. These values he calls the molecular moments of the liquids. J. W. P.

954. *Elastic Properties of Nickel-Steel.* **C. E. Guillaume.** (Soc. Franc. Phys., Séances, 3. pp. 248–252, 1903.)—The modulus of elasticity of nickel steels is in general less than that of the constituents, and falls, in the neighbourhood of the non-expansive alloys, to about three-quarters of the mean of the values for iron and nickel. Further, the modulus falls abruptly by about one-tenth in the transition from the non-magnetic to the magnetic state, whilst the elastic limit simultaneously shows a considerable rise. The method employed in the present investigation consisted in determining the rate of a chronometer provided with a hair-spring of the alloy to be investigated, and calculating the variation in the elasticity of the spring from the variation of the rate with the temperature. The variation of elasticity with temperature is expressed by the formula $E_t = E_0(1 + at + bt^2)$, and the following table shows how the elastic constants depend on the proportion of nickel in the less expansive alloys.

Nickel per cent.	E_0.	Elastic coefficients.	
		$a \times 10^6$.	$b \times 10^6$.
22	19·67	— 394	—
26·2	18·50	— 51	— 0·95
27·9	18·06	+ 104	— 1·72
30·4	15·96	+ 389	—
35·0	15·04	+ 464	—
44·5	16·40	— 44	— 0·62

[See also Abstract No. 791B (1904).] T. M. L.

955. *Resistance of Glass Tubing to Bursting Pressure.* **W. P. Bradley** and **A. W. Browne.** (Journ. Phys. Chem. 8. pp. 37–55, Jan., 1904.)—The authors find that it is not safe to rely upon the values of the bursting pressure of glass tubes calculated from determinations of the tensile stress. It is by no means invariably the case that a thick-walled tube stands a higher pressure than one with thinner walls. The measurements here described were made on the following varieties of glass: (1) Bohemian; (2) Jena; (3) Jena compound; (4) Greiner and Friedrich's soft glass; (5) E. Gundelach's soft glass: (6) "American" lead glass; (7) A new calcium glass of the Whitall Tatum Co. Great care in sampling was taken to obtain a uniform and perfectly central bore and freedom from taper. Each tube was sealed at one end into a regular hemispherical tip, and was then mounted by means of wax in the cap of a Cailletet apparatus, the pressure being then raised at intervals by successive increments of about 5 atmospheres. The nature of the fracture is almost invariably similar to that obtained when a bullet perforates a pane of window-glass; around the central hole is a roughly annular area containing small trapezoidal fragments or somewhat larger pieces from which such fragments have been broken, while still further away the pieces are of larger dimensions and have either blunted or sharp tips invariably pointing towards the centre. In most cases the centre of the rupture was located in the central third of the tube's length. Many of the tubes did not burst while the pressure was rising, but during the interval when the pressure was kept constant. The relative strength of the glass is

expressed by PB/W, where P represents the bursting pressure in atmospheres, B the bore in mm., and W the thickness of wall in mm. The glasses examined fall naturally into two divisions: (1) those with relative strength well above 1,000 atmospheres, comprising the soft and Jena glasses, and (2) those giving values considerably below 1,000, viz., the Bohemian and the calcium glass of the Whitall Tatum Co. The hardest glass has much the lowest relative strength, while the lead glass has the highest, which differs, however, very slightly from those of the Jena glass and of Gundelach's soft glass. The reliability of a glass, however, depends not only on the average strength obtained from a number of specimens, but also on the extent to which individual tubes vary from the average. In this respect, the lead glass is much more clearly the best than it is as regards strength, the value given by the most erratic tube being only 15 per cent. below the theoretical mean strength; then come the calcium, Bohemian and Jena glasses, the remaining soft glasses being very erratic. T. H. P.

956. *On the Motion of an Holonomous System of Rigid Bodies.* **M. Contarini.** (Accad. Lincei, Atti, 12. Note I. pp. 507–515, June 21, 1903. Note II. pp. 609–616, Dec. 20, 1903.)—The first note refers to an error made by the writer in the fifth part of his treatise on the general problem of seismography, already pointed out and partially corrected in the concluding parts of the same treatise. [See Abstract No. 387 (1903).] He also takes the opportunity of simplifying to some extent the general treatment of a system or chain of n rigid bodies. The system is said to be holonomous when the connections can be represented in finite terms by equations of the form $f(\xi_1 \ldots \zeta_n \phi_1 \ldots \omega^{t}_{h,}) = 0$, in which ξ_h, η_h, ζ_h are co-ordinates defining the position of the centre of inertia of the body C_h, referred to fixed axes, and ϕ_h, ψ_h, ω_h are three angular co-ordinates defining its orientation. The special case is examined in which the connections consist in two of the bodies having a point or a line in common. He promises in future papers to reduce the system to a chain of bodies, as in the former treatise on seismography, and also to find by a new method the differential equations which express the movements of the various seismographic instruments used in practice. In the second note the author continues his discussion of the geometry of a system of rigid bodies, between which certain connections exist. And these connections may take the form of two bodies having a point in common, and if only one such point, then the connections may be successive, so that the system is reduced to a chain. Attributing to any pair a point in common reduces the number of degrees of freedom of the system by three, or the connections may consist in two bodies having a line in common. The work done on a virtual displacement of the system is calculated for each case. He concludes by examining the case in which the chain of rigid bodies is suspended by one or more points from an external body the motion of which is supposed not to be affected by that of the suspended bodies. S. H. B.

957. *Particular Cases of the Problem of Three Bodies.* **P. Pizzetti.** (Accad. Lincei, Atti, 13. pp. 17–26, Jan. 3, 1904.)—The writer first supposes n bodies of masses $m_1, m_2 \ldots m_n$ not in one plane—attracting each other according to the Newtonian law. Referred to fixed axes through the common centre of inertia, their co-ordinates at the initial instant $t = 0$ are denoted by A_i, B_i, C_i; $i = (1, 2 \ldots n)$. Suppose a set of moving rectangular axes about the same origin, and let the direction cosines of these moving axes respectively with reference to the fixed axes be, for the new axis of x;

α_1, α_2, α_3; of y: β_1, β_2, β_3; and of z: γ_1, γ_2, γ_3. Then, if x_i, y_i, z_i be the co-ordinates of m_i referred to the moving axes at time t, we have—

$$x_i = \theta(\alpha_1 A_i + \alpha_2 B_i + \alpha_3 C_i)\,;\ y_i = \theta(\beta_1 A_i + \beta_2 B_i + \beta_3 C_i)\,;\ z_i = \theta(\gamma_1 A_i + \gamma_2 B_i + \gamma_3 C_i)\,;$$

where θ is a function of the time, supposed to have the same value for each of the n bodies. This is in order that the motion may be homographic, as is assumed. The attraction on m_i of the remaining bodies is then given by $\frac{d^2x_i}{dt^2} = \Sigma_s m_s . \frac{x_s - x_i}{\Delta^3_{si}}$ (s/i), with corresponding components in y and z. Here Δ is the distance $m_s m_i$ at time t. If θ and α, &c., are variable with the time he finds—

$$A_i \frac{d^2(\theta\alpha_1)}{dt^2} + B_i \frac{d^2(\theta\alpha_2)}{dt^2} + C_i \frac{d^2(\theta\alpha_3)}{dt^2} = \frac{1}{\theta^2} \Sigma m_s \cdot \frac{\alpha_1(A_s - A_i) + \alpha_2(B_s - B_i + \alpha_3(C_s - C_i)}{D^3_{si}}$$

where—

$$D^2_{si} = A_s - A_i)^2 + (B_s - B_i)^2 + (C_s - C_i)^2.$$

From these equations he deduces—

$$\theta^2 A_i \left\{ \alpha_1 \frac{d^2(\theta\alpha_1)}{dt^2} + \beta_1 \frac{d^2(\theta\beta_1)}{dt^2} + \gamma_1 \frac{d^2(\theta\gamma_1)}{dt^2} \right\} + \theta^2 B_i \left\{ \alpha_1 \frac{d^2(\theta\alpha_2)}{dt^2} + \beta_i \frac{d^2(\theta\beta_2)}{dt^2} + \&c. \right\}$$
$$= \Sigma m_s \frac{A_s - A_i}{D^3_{si}} + \theta^2 C_i \left\{ \alpha_1 \frac{d^2(\theta\alpha_3)}{dt^2} + \&c. \right\},$$

whence it follows, the bodies being more than two in number and not in one plane, that the coefficients of A_i, B_i, C_i in the last expression are constants. And if π, χ, ρ be the angular velocities of the system of moving axes, he makes use of the formulæ $\frac{d\alpha_1}{dt} = \rho\alpha_2 - \chi\alpha_3$, &c.—and deduces the result that the ratios π, χ, ρ are invariable—and so the direction of the instantaneous axis of rotation is invariable, and may be taken for the axis of z, so that $\pi = \chi = 0$. He finds that these conditions can be satisfied by (I.) $\rho = 0$, $\theta^2\theta'' =$ constant; or by (II.) $\rho =$ constant, $\theta =$ constant. But (II.) is shown to be impossible, so that (I.) is the only solution. And, according to it, each body moves as if it were affected only by the attraction of the common centre of mass. This is, then, the only possible homographic solution. The particular case, $n = 4$, is then considered, and it is shown that Lehmann-Filhe's solution, that of the four bodies being at the angles of a regular tetrahedron, is the only possible solution. Other particular cases discussed are those of the n bodies being in one plane, and of the n bodies being in one line. S. H. B.

958. *Kinetic Theory of Matter.* **H. C. Pocklington.** (Cambridge Phil. Soc., Proc. 12. pp. 283–292, Jan., 1904.)—It is pointed out that in formulating a kinetic theory of matter, or matter and ether, it is usually assumed (1) that the motion obeys Lagrange's equations, and (2) that the number of independent co-ordinates specifying the configuration is equal to the number specifying the velocities. The author then shows that the phenomena of an ordinary gas are inconsistent with the truth of (2). This is therefore rejected, and the assumption is made that the number of independent velocities is reduced by the existence of one or more non-integrable linear differential equations of condition of the first order. By the discussion of two particular cases the possibility is demonstrated of the passage of the whole energy of the system to

a few, or even one, of its degrees of freedom, and that the number of systems started from all possible configurations with all possible velocities may divide into discrete sets, in each of which some function of the co-ordinates and velocities has a definite value, which differs for the different sets. The various kinds of atom may therefore be different final states of the same systems, and the possibility of the transmutation of elements is not excluded. The only places where non-integrable equations of condition are to be expected, are in the relations between the atom and its charge, and in the relations between the charge and the disturbance which it produces in the ether. Our knowledge of the phenomena connected with the motion of isolated charges or charged atoms is insufficient either to locate or determine the equation. G. W. DE T.

959. *Propagation of Tremors over the Surface of an Elastic Solid.* **H. Lamb.** (Roy. Soc., Phil. Trans. 203. pp. 1–42, Jan. 6, 1904.)—The paper deals with the propagation of vibrations over the surface of a semi-infinite isotropic elastic solid, the vibrations being due to an arbitrary application of force at a point. In the problem most fully discussed, the force is an impulse applied perpendicularly to the surface. The surface disturbance (taking the surface as horizontal) may be divided roughly into the "minor tremor" and the "main shock." The former sets in, at any place, abruptly after a time equal to that taken by a wave of longitudinal displacement to traverse the distance from the source. Generally speaking, it consists of a long undulation leading up to the main shock, and then gradually dying away. The main shock is propagated as a solitary wave with one maximum and one minimum in both horizontal and vertical displacements, and its total energy remains constant: its velocity is that of free Rayleigh waves, and is thus somewhat less than that of waves of transversal displacement in an unlimited medium. The author considers his results in relation to seismic tremors over the surface of the earth. W. S.

960. *New Determination of Molecular Distance in Solids and Liquids.* **L. Décombe.** (Archives des Sciences, 17. pp. 133–138, Feb., 1904.)—The spectrum of the incandescent gas may be considered to be due to the almost unrestricted vibrations of its molecules. In solids and liquids the molecules are sufficiently close to mutually influence one another. This affects their vibrations, and consequently the spectrum due to a molecule in the body of a homogeneous incandescent mass is different to that of a molecule in the surface. The most extended spectra obtained may be taken as 15 m. long, and, if the slit be 50μ wide, there will be at least $15 \times 10^6 \div 50 = 3 \times 10^5$ rays of the same width in such a spectrum. Supposing each molecule to have, say, 100 distinct modes of vibration, the apparent continuity of the spectrum is due to the superposition of $3 \times 10^5 \div 100 = 3000$ spectra, *i.e.*, in the surface layer there are 3,000 sets of molecules vibrating differently, and therefore at different distances from the free surface. In general $3000 = N \times n$, where N is the number of molecules along a length of normal corresponding to the radius of molecular activity, and n is the number of normals for which the distribution is different. Taking as the lowest value $n = 2$, this gives $N \leqq 1500$. The value generally accepted for the thickness of the surface layer is $0{\cdot}05\mu$. Hence the minimum molecular distance is $0{\cdot}05/1500 = 1/30000$ micron, a value in good agreement with those of Lippmann and Kelvin.

G. E. A.

961. *Dynamical System illustrating the Spectrum Lines and Phenomena of Radio-activity.* **H. Nagaoka.** (Nature, 69. pp. 392–393, Feb. 25, 1904. Communicated to the Physico-Mathematical Society, Tokio.)—The system consists of a large number of particles of equal mass arranged in a circle at equal angular intervals and repelling each other with forces inversely proportional to the square of the distance between the particles. At the centre of the circle is placed a large particle attracting the other particles forming the ring according to the same law of force. If the repelling particles be revolving about the attracting centre, the system will remain stable for small oscillations which consist of the transversal vibration perpendicular to the plane of the orbit, together with the radial and angular disturbances representing the rarefaction and condensation in the distribution of the particles. Maxwell treated of such small oscillations in the case of Saturn's rings; the system will be the same if the repelling particles be substituted for the attracting particles. This system will be approximately realised if we place negative electrons in the ring and a positive change at the centre. The frequency of transversal vibration is given by—

$$n = \omega - am^2 + bm^4 + \ldots ,$$

where ω is the principal term and m the whole number. This formula gives the crowding of the spectrum lines when m is small and when it is large. Generally $a > 0$, so that as m increases, the intervals between the lines become wider. The distribution of the lines resembles that of a band spectrum degraded towards the red. Taking the converging point of the lines for large values of m as the beginning of the series, it is convenient to count the lines from this point where, let us say, $m = m_0$. Then putting $m = m_0 - m'$ and remembering that $dn = 0$ for $m = m_0$, we have $n = \omega' + a'm'^2 + b'm'^4 + \ldots$ This gives a spectrum of the carbon type, degraded towards the blue; it is, in fact, an extension of Deslandres' formula. If the particles are negative electrons we can easily prove that the above transversal vibration will not be sensibly affected by an external magnetic field, which is a characteristic of the band spectrum. The radial and angular waves propagating round the ring have frequencies given by $n = C/\sqrt{1 - Am^2 + Bm^4 \pi + \ldots}$ The lines in this case crowd together for large values of m towards a region of high frequency. This may be identified by the line spectrum, though m is not the same as in the formulæ of Kayser and Runge, or of Rydberg. The supposition that the particles are electrons leads to the conclusion that a single line is resolved in the magnetic field into doublets circularly polarised in opposite senses. The ring here considered is quasi-stable; it may be set to disturbances the radial and angular components of which are nearly proportional to $e\kappa^{vt}$, where κ is a constant, v the number of particles in a ring, and t the time. If the disturbance continue for a sufficiently long time, the ring will be torn asunder, and the particles will fly off with great velocity, if electrons, as β-rays, while the central positive charges will form the α-rays. The atom here considered will have high atomic weight when v is large, and consequently the instability is easier to produce when the atom is massive. The author suggests the application of the kinetics of this system to such investigations as actino-electricity, ionisation of flames, change of resistance on exposure to light, fluorescence, phosphorescence, &c., as many such and allied subjects may be accounted for by the resonance and forced oscillations to which the system is susceptible. [See also next Abstract.] E. C. C. B.

962. *Dynamical System illustrating the Spectrum Lines and the Phenomena of Radio-activity.* **G. A. Schott.** (Nature, 69. p. 437, March 10, 1904.)—The author has found that the system of Nagaoka's [see preceding Abstract] is unstable if the law of electric force be that of the inverse square and the magnetic force be neglected. Maxwell found the frequency equation for displacements perpendicular to the plane of a ring of revolving satellites to be $n'^2 = \mathrm{S} + (\mathrm{R}/\mu)\mathrm{J}$, where S is the mass of Saturn, R/μ that of each satellite, and the radius of the ring is unity. The displacements are of the type $\mathrm{Z} = \mathrm{C} \cos (m\theta + n't + \gamma)$, where C and γ are constants, m is an integer, and θ is the arc from a point on the ring to the satellite. If p be the number of satellites and r an integer, then $\mathrm{J} = \Sigma \sin^2 \frac{m\theta}{2} \sin^3 \theta$, with $\theta = \frac{r\pi}{\mu}$. In the case of the electrons $\frac{\mathrm{R}}{\mu}$ must be replaced by $\frac{-e^2}{\mathrm{M}a^3}$ if e be the charge and M the mass of an electron of the ring of radius a. If the central positive charge be qe, then we will have $\frac{qe^2}{\mathrm{M}a^3}$ in place of S. The frequency equation now becomes $n'^2 = \frac{e^2}{\mathrm{M}a^3}(q - \mathrm{J})$, and the angular velocity is given by the equation $\omega^2 = \frac{e_2}{\mathrm{M}a^3}(q - \mathrm{K})$, where $\mathrm{K} = \Sigma \frac{1}{2} \sin \theta$. Steady motion is possible as long as $q > \mathrm{K}$; this motion is stable (for these disturbances) if $q > \mathrm{J}$. All the terms of K and J are positive, and the lower terms increase very rapidly as p increases. The author finds that $\mathrm{K} > p$ when $p = 472$ about and that $\mathrm{J} > p$ when $p > 7$. For an electrically neutral system it follows that $p > 8$. Considering the case when $p = 8$, then $\mathrm{K} = 2{\cdot}8$; thus $\omega^2 = 5{\cdot}2 \times \frac{e^2}{\mathrm{M}a^3}$, and $n' = \sqrt{-1}\,\omega + 0{\cdot}78$. The time in which the disturbance is multiplied $e^{2\pi} = 535$ times is thus $1{\cdot}27 \times$ the period of revolution; this implies a high degree of instability when $p = 8$ and still more so for $p > 8$. Similarly for the radial and tangential disturbances the system is shown to be unstable. The author points out that the above is based on the assumption that the arrangement of the electrons is symmetrical. The effect of the magnetic force has not been taken into account, but there seems no reason why this should seriously effect the conclusions. E. C. C. B.

963. *Condition necessary for the Stability of an Elastic Medium.* **P. Duhem.** (Comptes Rendus, 138. pp. 541–544, Feb. 29, 1904.)—The author supposes an elastic substance enclosed within a fixed surface S, and not subject to the action of any external forces, and initially at uniform temperature T_0, and uniform density ρ_0. He makes use of the notation following. The co-ordinates of any point in the undeformed substance are a, b, c. The components of deformation are ξ, η, ζ, subject to the condition $\xi = \eta = \zeta = 0$ on S. Also $\varepsilon_1 = d\xi/da$, $\varepsilon_2 = d\eta/db$, $\varepsilon_0 = d\zeta/dc$,

$$\gamma_1 = \frac{d\eta}{dc} + \frac{d\zeta}{db}, \quad \gamma_2 = \frac{d\zeta}{da} + \frac{d\xi}{dc}, \quad \gamma_3 = \frac{d\xi}{db} + \frac{d\eta}{da}.$$

The thermodynamic potential is then $\Phi = \phi_0 (\rho_0, \mathrm{T}) + \phi_1 (\rho_0, \mathrm{T}) (\varepsilon_1 + \varepsilon_2 + \varepsilon_3) + \phi_2 (\rho_0, \mathrm{T}, \varepsilon_1, \varepsilon_2, \varepsilon_3, \gamma_1, \gamma_2, \gamma_3) +$ &c., in which ϕ_2 denotes a quadratic function of $\varepsilon_i\, \gamma_i$, &c., and + &c. includes only terms of higher orders of the very small quantities ξ, η, ζ. The dissipation function is $\mathrm{L} = f(\rho_0, \mathrm{T}, \varepsilon_1', \varepsilon_2', \varepsilon_3', \gamma_1', \gamma_2', \gamma_3') +$ &c.,

in which f denotes a quadratic function in ϵ_i', γ_i &c. and + &c. refers to terms of higher orders. The equations of motion are given in the form—

$$\frac{d}{da}\left(\frac{d\phi_2}{d\epsilon_1}+\frac{df}{d\epsilon_1'}\right)+\frac{d}{db}\left(\frac{d\phi_2}{d\gamma_3}+\frac{df}{d\gamma_3}\right)+\frac{d}{dc}\left(\frac{d\phi_2}{d\gamma_2}+\frac{df}{d\gamma_2'}\right)=0.$$

The required condition is found to be that, if the surface S be fixed, ϕ_2 cannot be negative consistently with stability.

It is remarked that no assumption is made concerning the effect of viscosity beyond the existence of the dissipation function. The same proposition can be applied to a vitreous medium in the form, that if we have in the initial state both $\mu < 0$, and $3\lambda + 2\mu < 0$, the equilibrium of the initial state, whether there be viscosity or not, cannot be stable if the bounding surface be fixed. S. H. B.

964. *Structure of the Atom.* **J. J. Thomson.** (Phil. Mag. 7. pp. 237–265, March, 1904.)—An atom is assumed to consist of a number of corpuscles in motion within a sphere of uniform positive electrification. The author then attempts to determine by analysis the structure of such an atom, and the properties which follow from such structure. In the general case the corpuscles will arrange themselves in concentric shells, but, to simplify the analysis, the author assumes that the corpuscles are constrained to move in a plane, which will not cause any essential alteration in the nature of the results obtained. In this manner a number of definite results of great interest and importance are obtained; amongst others, a demonstration of the existence of secondary groups of corpuscles within the atom, and that an atom which is stable for a certain angular velocity of the corpuscles may become suddenly unstable when the angular velocity falls below a certain critical value. A sort of explosive action will then take place, the potential energy decreasing, and the kinetic energy increasing, and parts of the atom may be shot off, explaining the phenomena of radio-activity. Owing to the slow dissipation of energy by radiation, the life of the atom would be very long. G. W. DE T.

965. *Internal Friction of Solutions.* **J. Wagner** [and in part **J. Mühlenbein**]. (Zeitschr. Phys. Chem. 46. pp. 867–877, 1903. Phys. Chem. Lab. der Universität, Leipzig, 1903.)—The internal friction of a solution is usually reckoned on equal volumes, but the weight of water (w) in a litre of normal solution varies from 939·15 gm. in the case of cæsium chloride, and 940·87 gm. in the case of aluminium sulphate, to 999·17 gm. in the case of copper sulphate, and 999·92 gm. in the case of nickel sulphate, and although there is no direct quantitative relationship it is nevertheless noticeable that the viscosities (η) run to some extent in the same order as these weights of water. Thus, in the case of the substances which actually reduce the viscosity of water the values are :—

	w.	η.
$TlNO^3$....................	958·66	0·9471
CrCl	939·15	0·9775
RbCl	940·15	0·9846
KCl	972·05	0·9872
KNO_3....................	959·36	0·9753

Tables are given showing the viscosity of a number of organic solutions that have been examined from this point of view, together with the weight of solvent in a litre of the normal solution. T. M. L.

966. *Dielectric Cohesion of Gases.* **E. Bouty.** (Soc. Franç. Phys., Séances, 2. pp. 96–129, 1903. Journ. de Physique, 2. pp. 401–434, June, 1903.)—Revision and correction of previous papers by the author. Dielectric cohesion is equivalent to "electrical strength" considered not in reference to sparking but to the passage of electricity through a bulb without electrodes placed in a sufficiently strong electrical field, one above the "critical value." The passage of electricity, if any, is revealed either by a visible glow or by an apparent increase in the capacity of the condenser between whose plates the bulb is placed. Various causes of error are discussed, and recent precautions described. The critical strength of field (volts/cm.) is of the form—

$$a + b\sqrt{p(p+e)} + \frac{l}{p} + \frac{n}{p^2}$$

where a is often $= 0$ and either l or $n = 0$. The term $b\sqrt{p(p+e)}$ is hyperbolic in form, and at high pressures (up to 10·8 cm.) the asymptote to this practically represents the critical strength of field as a linear function of the pressure; as the pressure falls the critical strength of field falls to a minimum and then rapidly rises, but below 1/10 mm. Hg fails to keep up this increase. The value of the coefficient b is a specific constant of the gas, and that of e appears also to be so; and the term $b\sqrt{p(p+e)}$ is not affected by the nature of the walls of the bulb nor by the thickness of the layer of gas acted upon. The coefficient l varies inversely with the thickness of the layer of gas; so that at low pressures the difference of potential (= strength of field × thickness of gas) is almost constant under similar conditions, but depends upon the nature of the gas and on the nature and the condition (particularly as regards gas adherent to it) of the wall surrounding the gas. The coefficient a comes in when the layer of gas is very thin. At the minimum critical strength of field the total difference of potential across it is remarkably constant, for the same gas. As compared with the electrical strength in respect of minimum sparking, this dielectric cohesion resembles it (1) in that for pressures above some millimetres of mercury the necessary difference of potential is proportional to the thickness, (2) in that at high pressures (say 1 atmo.) and for thick layers the critical field for silent and that for explosive discharge are the same, (3) in that at relatively high pressures the variation of potential is approximately proportional to the pressure (but for short spark distances, of 1 mm. only, the influence of the electrodes is considerable and varies according to the nature of the gas), and (4) in that a certain minimum difference of potential is necessary in both cases. The author is inclined to reserve the name dielectric cohesion for his constant coefficient b, 425 volts for air, 418 for CO_2, 205 for H, per cm. thickness and per cm. of mercury pressure. The resistance offered by the gas itself at low pressures becomes very small in comparison with that presented at the bounding wall; and probably very high potentials would not be required for silent discharges in the upper regions of the atmosphere. At the bounding wall we have an adherent film of gas which at low pressures preponderates in its effect over the volume of gas itself. There seems to be no conveyance of electricity in the gas without actual travel of matter, and there seems to be an exchange of matter between the free gas and the adherent film of gas. The fall of potential measures the work per unit of quantity passing, and the amount of work depends upon the number of encounters (M. Wolf has shown that $b \propto$ the mean free path) which cause an internal friction in the gas; but at the bounding walls the exchange of particles becomes difficult (causing a kind of solid friction) when the pressure is low, because the walls are not in that case saturated with a film of adherent gas; and this tells sooner with gases such as hydrogen which are not readily condensed. [See also Abstract No. 262 (1904).] A. D.

967. *Dielectric Cohesion of Gases and Temperature.* **E. Bouty.** (Journ. de Physique, 3. pp. 12–28, Jan., 1904. Communication made to the Société Française de Physique, Dec. 4, 1903.)—Under constant volume of the gas, the dielectric cohesion is, between —100° and + 200°, independent of the temperature, both in pure gases and in mixtures of gases. (The silent transmission of electricity through an H_2-O mixture does not produce an explosion, nor any chemical combination.) The law seems to apply at lower temperatures than —100°; but at the higher temperatures it is apparently, but only apparently, interfered with by the conductivity induced in the glass of the bulb containing the gas. This begins to tell with glass at 90°, with crystal glass at 133° to 189°; and the effect is that the walls of the bulb, being charged oppositely to the nearer plate of the condenser, reduce the resultant field within the bulb to an extent which rapidly increases with the temperature. This property and the constancy of refractive power practically sum up the constant properties of gases at constant volume; to them might be added constancy of the dielectric constant. These point towards their dependence on the individual molecule; and constancy of the dielectric cohesion would signify that the kinetic energy which an ion must possess in order to ionise a neutral molecule is independent of the temperature. At very low pressures high temperatures tend to wear off the adherent film of gas on the walls of the bulb and thus to act as if the pressure had been still farther reduced. [See Abstract No. 966 (1904).] The parallelism between the electrical strength in respect to sparks and the dielectric cohesion in respect to silent convection of electricity would seem to apply also here, but with, in the meantime, some reserves arising out of Baille's experiments (Annal. Chim. Phys. 5. 29. pp. 187–189, 1883). A. D.

968. *Dielectric Cohesion of Argon and its Mixtures.* **E. Bouty.** (Comptes Rendus, 138. pp. 616–618, March 7, 1904.)—The dielectric cohesion of argon is 6·8 times smaller than that of hydrogen and 14 times smaller than that of air; it is so remarkably increased by the presence of even slight impurities as to afford a test of purity comparable with spectrum analysis. It shows discontinuity at a pressure of about 16 cm. of mercury, at which the spectrum begins to show red rays less refrangible that that of H, which are not exhibited at higher pressures and which are brightest at the pressure 0·3 cm. The electric glow in pure argon at high pressures is very bright and of a beautiful bluish white; it becomes much paler and takes a greenish-yellow tint on addition of slight traces of other gases, the more refrangible parts of its spectrum being much weakened; and the more the dielectric cohesion is varied, the more is the spectrum modified. Its dielectric cohesion at constant volume is independent of the temperature between 200° and —20° C., but linearly decreases between —20° and —50° to about half its former value, and remains constant below —50°. R. E. B.

969. *Compressibilities of Oxygen, Hydrogen, Nitrogen, and Carbonic Oxide and the Atomic Weights of the Elements Concerned.* **Rayleigh.** (Roy. Soc., Proc. 73. pp. 153–154, March 7, 1904.)—The following table gives the values of B—the value of pv at 0·5 atm. pressure divided by its value at 1 atm. pressure—determined by the author; Oxygen, 1·00040; hydrogen, 0·99976;

nitrogen, 1·00017; carbonic acid, 1·00028. Assuming, as has been done by Regnault and van der Waals, that at small pressures the equation of an isothermal is: $pv = \mathrm{PV}(1 + ap)$, where PV is the value of the product in a state of infinite rarefaction, then $a = 2(1 - \mathrm{B})$. Taking oxygen as a standard, we see that the small correcting factor to be introduced in order to pass from the ratio of densities at 1 atm. to that at great rarefaction is $(1 + a)/(1 + a_0)$ or $1 + 2(\mathrm{B}_0 - \mathrm{B})$, the suffix 0 relating to oxygen; the values are, hence: Hydrogen, 1·00128; nitrogen, 1·00046; carbonic oxide, 1·00024. Twice the first of these, viz., 2·0026, represents, according to Avogadro's law, the volume of hydrogen combining with 1 volume of oxygen at atmospheric pressure to form water. Direct determinations by Scott gave 2·00245, and by Morley, 2·0027. The following table gives the densities of the various gases, referred to oxygen as 16, deduced from the author's observations:—

	Atmospheric pressure.	Very low pressure.
Hydrogen	1·0075	1·0088
Nitrogen	14·003	14·009
Carbonic oxide	14·000	14·003

The researches of Leduc and Morley show that the above numbers for hydrogen are a little, perhaps one-thousandth part, too high. The value for nitrogen, 14·009, differs considerably from Stas' value for its atomic weight, viz., 14·05; if Avogadro's law is strictly true, the latter number is impossible. The molecular weight of carbonic oxide, 28·006, gives the value 12·006 for the atomic weight of carbon. T. H. P.

970. *Southerly Motion of Falling Bodies.* **E. H. Hall.** (Phys. Rev. 17. pp. 179–190, Sept., and pp. 245–254, Oct., 1903. Amer. Acad., Proc. 39. No. 15, pp. 339–349, Jan., 1904.)—The author first gives a historical account of this subject in which theory is against, and experiment for, the motion. The work of Hooke, Guglielmini, Benzenberg, Reich, and Rundell is considered and criticised. The author's own experiments, made in the tower of the Jefferson Physical Laboratory, are then described. The height of fall is 23 m., and the balls used are 2·54 cm. in diam. The precautions against draughts and the elaborate releasing and receiving apparatus are described. The mean S. deflection from the plumb-line position is found to be 0·005 cm., with a probable error of 0·004 cm., and this the author concludes is for a hypothesis of southerly motion. The easterly motion is also measured and is found to be 0·149 cm., which is in moderately good agreement with the value for such a fall given by Gauss's formula, viz., 0·179 cm. A fuller description of the apparatus and various devices tried is given in the second paper referred to. J. W. P.

971. *Deflections of the Plumb-Line in India.* **S. G. Burrard.** (Phil. Mag. 7. pp. 292–294, March, 1904.)—From astronomical observations the author had deduced that a chain of excessive density, many hundred miles in length, lies hidden in the earth's crust in Upper India. In this assumption he differs from O. Fisher [see Abstract No. 701 (1904)]. As only one line of pendulum stations crosses this chain at right angles, he has not drawn attention to the Indian pendulum observations, the results of which have, moreover, been questioned. Pendulum observations show the excess or deficiency of matter in the crust immediately under the station, but give no clue as to the length and breadth of the rocks; at higher elevations deficiencies in gravity are

noticed. This would explain why maximum values of vertical force are observed both at Kalianpur, on the assumed hidden chain, and at Usira, outside this chain, but at lower elevation. H. B.

972. *Hertz Waves from the Sun, Solar Activity, and Terrestrial Magnetism.* **C. Nordmann.** (Journ. de Physique, 3. pp. 97–120, Feb., 1904. Paper read before the Société Française de Physique, Nov. 20, 1903.)—Having referred to the parallelism between the sun-spot period and the period of mean terrestrial temperature [see Abstract No. 715 (1904)], the author points out that there can be no direct magnetic action of the sun (disproved by Kelvin in 1892), nor can the sun act by a thermal modification of the magnetic susceptibility of the atmospheric oxygen (Faraday) or of the electric currents circulating in the atmosphere (B. Stewart). He suggests that Hertzian waves, which vary with the degree of insolation, enable electric currents produced by terrestrial induction to pass through the upper atmospheric strata. The diurnal variation in the magnetic elements changes with the seasons and has its maximum in the Northern Hemisphere (Nice) in June, when it has its minimum in the Southern Hemisphere (Batavia), and the variation decreases with increasing latitude, it being 0·374 at Bombay and 0·184 at Greenwich. As regards the eleven years' sun-spot period, he refers to Moureaux' tables. The intensity of solar activity, not the size of the spots, is decisive. Hertz waves explain the phenomena better than kathode rays (Goldstein, Deslandres, Birkeland), because the solar perturbations are propagated with the velocity of light and act independently of the heliocentric longitude of the centres of solar activity. H. B.

973. *Spectrum of γ Cygni.* **J. N. Lockyer** and **F. E. Baxandall.** (Roy. Soc., Phil. Trans. 201. pp. 205–222, June 19, 1903. Roy. Soc., Proc. 71. p. 240, Feb. 13, 1903. Abstract.)—The authors have investigated the spectrum of γ Cygni in relation to various other celestial and terrestrial spectra, and it is pointed out that it is the connecting link between stars like Aldebaran, in which the arc lines of the elements predominate, and stars like α Cygni, chiefly composed of the "*enhanced*" lines of some of the metals. In fact these two sets of lines are of about equal prominence in the γ Cygni spectrum. From the comparisons given of the relative intensities of the metallic and proto-metallic lines, it appears that there is a very close resemblance between the spectrum of γ Cygni and that of the solar chromosphere, thus indicating that the electrical conditions and temperature prevailing in the two light sources are almost identical; on a more minute comparison, evidence is adduced to indicate that the chromosphere is probably slightly hotter than the star. The majority of the spectrum lines in both these light sources can be traced to metallic vapours, and there appears to be little evidence to support the suggestion of Dewar that most of the chromospheric lines are due to the rarer atmospheric gases. The relation of the γ Cygni spectrum to that of α Cygni is also discussed in detail. At the end of the paper a table is given showing the wave-lengths, intensities, and probable origins of the lines in the spectrum of γ Cygni taken at Kensington with a 6-in. Henry prism of 45° angle. C. P. B.

974. *True Value of the Greater Axis of a Cometary Orbit when the Star is very distant from the Sun; the supposed Hyperbolic Character of Comet* 1890 *II.* **L. Fabry.** (Comptes Rendus, 138. pp. 335–337, Feb. 8, 1904.)—In cal-

culating the original orbit of a comet it is necessary to take account of the attraction exerted by the planets as well as the sun; this might easily be forgotten, because it is of little influence when the comet is very far distant. Considering the semi-great axis a, this is connected with the velocity v by the well-known formula $\frac{1}{a} = \frac{2}{r} - \frac{v^2}{\text{and } (1+\mu)}$, where r is the radius vector of the star, and the attraction due to the sun's mass, and μ the ratio of the total mass of the planets to that of the sun, which is equal to 0·001337. As a is very great, the error introduced by neglecting μ is nearly equal to $\frac{2\mu}{r}$, and is therefore negligible for large values of r, but quite sensible when r is more moderate. For example, when $r = 20$ the error is above 0·0001, and is no longer negligible. In calculating the eccentricity of comet 1890 II, Strömgen omitted the above, and arrived at a value of $\frac{1}{a} = -0{\cdot}000062$, which pointed to a hyperbolic orbit. If, however, we take account of μ as above, then we have $\frac{1}{a} = +0{\cdot}000090$, which leads to the conclusion that the original orbit was elliptical. E. C. C. B.

REFERENCES.

975. *Modulus of Traction and Coefficient of Dilatation of Vulcanised Caoutchouc.* **Bouasse** and **Carrière.** (Comptes Rendus, 136. pp. 1130–1131, May 11, 1903.)—This modulus and coefficient vary very much according to the previous history of the rubber and according to the time which has elapsed since prior operations upon it. A. D.

976. *Hydrogen-liquefying Apparatus.* **K. Olszewski.** (Acad. Sci. Cracovie, Bull. 5. pp. 241–246, May, 1903.)—Improvements upon the apparatus previously described [see Abstract No. 907 (1903)], resulting in a considerable economy in the amount of liquid air required for cooling, and in simpler and less bulky jacketing. A. D.

977. *Navigation.* **G. W. Littlehales.** (Phil. Soc. Washington, Bull. 14. pp. 233–246, Nov., 1903.)—The author describes an abridged method of finding, by reference to section plates in a volume and without the whole of the usual computations, the zenith distance and azimuth of a celestial body necessary in order to determine the Sumner line on which the ship is situated. Illustrative plates and problems are given; also a compensation method for eliminating errors in ascertaining the altitude; and a method for ascertaining the name of an unknown star observed, say, through a rift in the clouds. A. D.

978. *Chemical Balances.* **J. S. Lumsden.** (Chem. News, 89. pp. 11–12, Jan. 1, 1904.)—New designs for school balances; all weights below 1 gm. are provided for by rider weights of a ring shape, permanently kept on the balance. An auxiliary beam, one-fifth the length of the main beam, is used, with a 5-centigm. rider, for milligrammes. Also a new method of graduating the beam, on both sides from left to right, so that a centigm. rider on the farther-out O mark balances a decigm. rider on the nearer-in O mark, and the marks on which the decigm. and the centigm. riders respectively stand give the respective numbers for centigrammes and milligrammes; this method being due to S. J. Shand. A. D.

979. *Synchronisation of Clocks.* **J. Andrade.** (Archives des Sciences, 17. pp. 139–160, Feb., 1904.)—Development of the theory of the subject [see Abstract No. 256 (1904)]. A. D.

980. *An Improved Chronograph.* **R. L. Mond** and **M. Wildermann.** (Comptes Rendus, 138. pp. 494–495, Feb. 22, 1904.)—It is claimed that a type of chronograph has been produced which is free from the faults possessed by other designs. Time measurements can be made to an accuracy of from $\frac{1}{50}$ to $\frac{1}{200}$ sec.
W. W. H. G

981. *Regulating Apparatus for Distillation under Reduced Pressure.* **J. Rutten.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 793–796, March, 1904.)—An automatic mercury valve combined with manometer, which is easy of construction and has proved to be very efficient. H. H. F. H.

982. *Calibration of Manometer and Piezometer Tubes.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 532–541, Feb. 25, 1904. Translated from Versl. van de gewone vergadering der Wis- en Natuurkundige Afdeeling, Jan. 30, 1904. Communication from the Physical Laboratory at Leiden.) —This is connected with Abstract No. 1101 (1904). The author reduces the determinations by using three terms of a Fourier series, and reaches a higher accuracy than otherwise attainable. H. H. F. H.

983. *Lateral Strain in Beams.* **J. Morrow.** (Roy. Soc., Proc. 73. pp. 13–31, Feb. 11, 1904.)—Little attention has been devoted to the lateral strain accompanying a simple tensile or compressive strain, or to the lateral strain occurring in a bar under bending forces. The author has designed an instrument suitable for the accurate measurement of the lateral displacements in the section of a beam. This is described in Abstract No. 691 (1904). It was found that the arrangement is very sensitive to vibrations, and accurate readings could only be taken when the machinery in the adjacent laboratories was at rest. On applying the load a small jerk, quite unavoidable, caused a very slight displacement of one of the mirrors, which could not be detected on looking in the telescope, but nevertheless was sufficient to vitiate the accuracy of the readings. To eliminate this error the load was applied and removed several times, and if the readings were consistent and returned each time to the original value when the load was taken off they were accepted as correct.
W. W. H. G.

984. *Simple Demonstration of the Fundamental Gas Formula.* **T. Schwedoff.** (Journ. de Physique, 3. pp. 215–216, March, 1904.)—A perfectly elastic molecule of mass m, moving with speed u in a sphere of radius r and striking its surface at angle a, exerts on it a normal impulse $2mu\cos a$ at each reflexion, *i.e.*, $u/2r\cos a$ times a sec., and thus may be looked on as exerting on the whole a normal force of mu^2/r, which is the same as if it rolled along the surface. If, then, there are n molecules per unit volume, they produce a normal force of $\frac{4}{3}\pi r^3 n\,.\,m\mathrm{U}^2/r$ or a normal pressure $p=\frac{1}{3}mn\mathrm{U}^2$, where U is the speed of mean square, the mutual collisions of particles rolling on a sphere not affecting the force they exert upon it. This result is easily generalised. R. E. B.

985. *Saltness of the Dead Sea.* **W. Ackroyd.** (Chem. News, 89. p. 13, Jan. 8, 1904. From the Quarterly Statement of the Palestine Exploration Fund.)—The saltness of the Dead Sea is regarded as being largely due to the atmospheric transport of salt from the Mediterranean, in which the ratio of chlorine to bromine is almost exactly the same as in the Dead Sea. The percentage of chlorine in the limestones of Palestine is not above the normal, and amounts only to about 0·01 per cent. reckoned as NaCl, and the theory that the salt is derived from the rocks by solvent denudation is therefore untenable. So also the theory that the Dead Sea represents an arm of the Red Sea cut off by the rising of Palestine in past ages, in which the saltness has been increased by evaporation, is incompatible with the fact that a precipitation of salt has been taking place continuously for an unknown length of time. T. M. L.

986. *Coronal Method of Estimating Atmospheric Nucleation.* **C. Barus.** (Phys. Rev. 17. pp. 233–244, Oct., 1903.)—An account of observations of autumn, winter, and spring nucleations. The complications to which the method of coronal registry of atmospheric nucleation is incident are shown. On account of the practical convenience of the method a complete revision of coronas in relation to nucleation was afterwards undertaken by the author. J. J. S.

987. *Micrometric Measurement of Fog Particles.* **C. Barus.** (Amer. Journ. Sci. 17. pp. 160–170, Feb., 1904.)—An account of a method by which fog particles were observed with a microscope and their diameter directly measured. The observed values for phosphorus nuclei, amongst others taken, varied from 0·00036 cm. to 0·00080 cm. Air nuclei of diameters 0·00064, 0·00052, and 0·00048 cm. were observed. J. J. S.

988. *Report of the Chief of the Weather Bureau.* **W. L. Moore.** (Pp. 3–46, 1903.)—Report for year ending June 30, 1903.

989. *Abnormal Variation in Insolation.* **H. H. Kimball.** (Monthly Weather Rev. 31. pp. 232–233, May, 1903.)—Dufour having observed a diminution in the solar radiation during the first months of 1903 [see Abstract No. 1330 (1903)], the author communicates the preliminary results of observations made with an Ångström electrical compensation pyrheliometer, at Asheville and Black Mountain, in N.C., at an altitude of 2,200 ft. There were no previous comparative data, and the author points out that the diminution may be due to volcanic dust, but also to the abnormal meteorological conditions and the unusual amount of aqueous vapour. H. B.

990. *Problem of the Cyclone.* **F. J. B. Cordeiro.** (Monthly Weather Rev. 31. pp. 516–521, Nov., 1903.)—Relying upon Kelvin's demonstration that a fluid mass in vortex motion acquires the rigidity and elasticity of a solid, and referring to J. G. Barnard's paper on gyroscopes, the author rests his cyclone theory on the assumption that a cyclone is a gyroscope revolving simultaneously about its own axis and the axis of the earth. He applies the theory to the Porto Rico hurricane of Aug. 7, 1899. Those hurricanes do not conform to the coast-line of the West Indian islands and of North America, as is often said; but the opposite may be true. H. B.

991. *Diminution in Intensity of the Solar Radiation in* 1902 *and* 1903. **L. Gorczyński.** (Comptes Rendus, 138. pp. 255–258, Feb. 1, 1904.)—Tables are given showing the mean values of the solar radiation, expressed in gm. calories per sq. cm. per min., for each month of 1901, 1902, and 1903. These show a steady decrease, especially between December, 1902, and March, 1903; after this the decrease appears to be less decided. These facts have been observed by several others, but no satisfactory explanation is at present forthcoming, although it has been suggested that the increased opacity of the atmosphere was due to the Martinique eruption. E. C. C. B.

992. *Seiches in Lake Garda.* **J. Valentin.** (Monthly Weather Rev. 31. pp. 532–533, Nov., 1903.)—Preliminary results of observations. If the whole basin is considered, the uninodal oscillation period should be 47·45 min.; disregarding certain extensions, the actual period 43 min. results. Besides this, oscillation periods of 22·6, 30·15 min., &c., are observed, corresponding to the first and second quints and the first and second octaves. H. B.

993. *Questionable Type of Temporary Stars.* **J. G. Hagen.** (Astrophys. Journ. 17. pp. 281–285, May, 1903.)—Discusses five recorded cases of sudden variations in brightness, viz.: (1) U. Scorpii, in 1863; (2) T. Bootis, 1860; (3) U. Geminorum, 1856; (4) ζ Lyræ, 1850; (5) observations by Scheiner of a star in constellation Leo, in 1612. H. F. H.

994. *Seiches in Loch Ness.* **E. Maclagan-Wedderburn.** (Roy. Soc. Edinburgh, Proc. 25. pp. 25–26, 1903–4. Abstract.)—Three types of seiches have been observed at Fort Augustus by members of the Lake Survey [see Abstract No. 2199 (1902)] with a Sarasin limnograph. The periods are 31·5, 13·3, 8·8 min. The first, probably uninodal, period is rare, possibly owing to a current from the narrow channel connecting Loch Ness to Loch Dochfour; the formula $t=2\int dl\sqrt{b/ag}$, where b is the breadth and a the area of a cross-section, would give 42 min., while $t=2\int dl\sqrt{gh}$ yields 30·9 min. The period of the binodal seiche, 15·3 min., is less than half that of the uninodal, while according to du Boys it should be greater than half; Lake Geneva is also an exception to this rule. The polynodal seiche of 8·8 min. is sometimes very regular, though of small amplitude. The nodes have not yet been located. There are further oscillations of still shorter period. Sudden local variations of atmospheric pressure seem to be the cause of the seiches. H. B.

995. *Composition of the Waters of Swiss Lakes.* **E. Bourcart.** (Archives des Sciences, 17. pp. 169–185, Feb., 1904.)—Advised by Duparc and A. Delebecque, the author has analysed the waters of 24 Alpine lakes without examining the suspended matter. In one case (Lake Ritom) he found the water from 15 m. depth downward saturated with H_2S. None of the lakes are more than 60 m. in depth. The waters of different lakes differ strongly in composition; the minerals are taken up from the basin of the feeders, not from the lake bottom; there is no relation between colour and transparency; the Lac Bleu seems to owe its colour not only to its purity and the absence of organic matter, but to its contents of magnesia salts. H. B.

996. *Colour of Lakes.* **O. d'Aufsess.** (Archives des Sciences, 17. pp. 186–200, Feb., 1904. Extract.)—The author made his observations with the aid of the light of the sky and of a Nernst lamp, of a Martens-König spectrophotometer, and of a zinc tube, 6 cm. in diam., 5·5 m. in length. The absorption bands of distilled water remained practically unchanged after precipitation of all the dust particles with zinc chloride. Experiments with turbid distilled water and with waters from various depths of nine Bavarian lakes show that turbidity only alters the intensity of the colour, not the character of the absorption, while the addition of dissolved lime salts to distilled water changes the colour into green. The author therefore believes the colour to be due to chemical composition, and not to diffraction in the sense of Soret and Rayleigh. Pure water has absorption bands in the red and also in the orange, and is very transparent to blue. The more the blue rays are absorbed, the more the naturally blue colour turns into green, yellow and, finally, brown. H. B.

997. *Physico-Chemical Determination of Deep-Sea Currents.* **Thoulet.** (Comptes Rendus, 138. pp. 527–529, Feb. 22, 1904.)—At the corners of a triangle, a couple of hundred miles apart, water samples are taken at different depths in order to determine the normal density at 0°, the density *in situ* at $\theta°$, the density *in situ* corrected for the hydraulic pressure, and the percentages of Cl and of SO_4 in 1 kg. of water. From these data the direction, intensity, and dip of the currents can be deduced. Measurements were made on this plan from the *Princesse Alice* near the Azores, in 1902, to depths of 2,000 and even 6,000 m., and the figures and diagrams are reproduced on the paper. H. B.

998. *The Andover Meteorite.* **H. A. Ward.** (Amer. Journ. Sci. 15. pp. 395–396, May, 1903. Paper read before the Rochester Academy of Science, Nov. 10, 1902.)—The meteorite fell near Andover, Maine, U.S., on Aug. 5, 1898; a big piece, 7½ lbs. in weight, and several small pieces were then recovered. Fractures show brilliant points of nickeliferous iron sparsely interspersed with troilite; details are not given. H. B.

LIGHT.

999. *Floating Refracting Telescope.* **H. Grubb.** (Roy. Dublin Soc., Proc. 10. 11. pp. 133–137, Feb. 10, 1904.)—In this proposed mounting, Hale's method of shortening the telescope tube is adopted, *i.e.*, a plane mirror is placed in the path of the rays from the object-glass and reflects them back to the eyepiece set in the side of the tube near the object-glass. The mounting was designed for a latitude of 25°, and was so arranged that while a certain percentage of the weight rests on the bearings, as much as 95 per cent. was relieved by floating on water; this is equally true of both declination and polar axes. In the present design, which is for a refracting telescope of 48-in. aperture, the moving parts of which would weight about 60 tons, the tube is enlarged near its lower end into a sphere, the construction and distribution of weights being such that the centre of gravity of those portions of the instrument carried on the declination axis—that is to say, the tube, object-glass, mirror, and sphere—shall precisely coincide with the centre of the sphere. If this be correctly carried out, the system will float in water at any angle and in any position. The polar axis consists of a slightly larger sphere, supplied with bearings mounted at the proper angle, in which the telescope, with its inner sphere, is placed; and sufficient water is supplied to the space between the two spheres to almost float the telescope with its inner sphere. The outer sphere is itself floated in a third outer sphere, or portion of a sphere, which is supplied with sufficient water to float the whole of the moving parts. The result of the whole is that all parts are in perfect equilibrium, no matter what positions they are placed in; any portion of the weight of the instrument can be relieved off the bearings either of the polar axis or the declination axis and still leave all parts in a perfect state of equilibrium. The advantages to be found in this method of mounting are the following:—(1) No matter what the weights of the moving parts, such an instrument should work with the ease and accuracy of an instrument of one-tenth the weight. (2) The dimensions of the instrument and the building to cover it are all reduced in a large proportion. (3) On account of the short radius which the eyepiece describes as compared with the other forms of telescope, the difficulties connected with the position of the observer are very much decreased. Plates are given showing the instrument when completed, and also the old form of mounting for a telescope of same size. E. C. C. B.

1000. *New Auto-collimating Spectroscope.* **C. Fabry** and **A. Jobin.** (Journ. de Physique, 3. pp. 202–208, March, 1904.)—No separate collimating lens is used. The advantages claimed are compactness, and ease of adjustment by the observer; the disadvantage, a slight extra loss of light. After passing through the slit, the rays are reflected at 90° by a prism on to a lens of 100 cm. focal length; the rays then pass through two 60° flint-glass prisms in succession, after which they are reflected back again along their original path by a mirror, till they reach the eyepiece or photographic plate behind the first prism. The adjustments are explained in detail, and it is shown that if the first 60° prism is rotated on its axis through an angle a to bring it to the position for minimum deviation, then the second prism must be rotated through $3a$ and given a lateral movement, and the mirror through $4a$ with a lateral movement also. By means of mechanical gearing, which is fully described, any adjustment made to the second prism is communicated to the first and to the mirror, so that these three pieces always maintain their correct relative positions. For ocular observations, four eyepieces are provided of 35, 24, 20, and 12 mm. focal lengths, giving magnifications of about 30, 40, 50, and 80. The authors point out that the quality of a spectroscope is best defined by stating the length of spectrum on the plate corresponding to a difference of one wave-length; for spectra obtained with prisms, this distance depends on the wave-length. Below are such figures for the authors' and other spectroscopes:—

λ.	Length taken up on Plate for each Wave-Length.	Spectroscope.
$5{,}500 \times 10^{-7}$ mm.	1·1 mm.	Fabry and Jobin
4,500	1·35	„ „
3,700	3·4	„ „
4,340	2	„ „
„	1·4	Bruce (Yerkes)
„	0·8	Mills (Lick)

H. F. H.

1001. *Photographic Reversals in Spectrum Photographs.* **R. W. Wood.** (Astrophys. Journ. 17. pp. 361–372, June, 1903.)—Photographic reversals may be divided into five types, as follows. First type: The ordinary overexposure reversal, which occurs when the plate is given 300 or 400 times its normal exposure. Second type: The reversals produced by developing the plate in full lamplight, the plate having been more or less overexposed to begin with. Third type: A type of reversal which occurs if the plate is exposed to light for a minute or two between the developing and fixing. Fourth type: The Clayden effect, which occurs when an exposure of about 1/1,000 sec. is given, and the plate subsequently fogged by exposure to diffuse daylight before developing. If images of electric sparks be thrown upon a plate, and the plate be then exposed to the light of a candle for a few seconds, the spark images will develop reversed, which will not be the case if the exposure to candle-light precede the impression of the spark images. Fifth type: The last effect can be imitated by treating the plate, after exposing portions of it to the action of a feeble light for a few seconds, with a bath of potassium bichromate and nitric acid. If the plate is dried and then fogged by exposure to candle-light and developed, the previously exposed portions come out reversed. The author deals principally with the Clayden effect in this paper, and first with the relation of the phenomenon to the wave-length of the light. A plate was exposed to the spectrum of one or more sparks between cadmium electrodes, six impressions being taken with different diaphragms. The plate was then exposed to candle-light for a few seconds and developed. Those with the larger diaphragms were not reversed at all, while those in which the initial light shock was less intense were completely reversed, showing that there is no selective reversibility as far as the initial light shock is concerned. Experiments to test whether there is any selective reversibility as regards the fogging light also gave a negative result. This is interesting, as Röntgen rays will not reverse spark images. As regards the time factor of the initial shock it was found that this can last as long as 1/1,000 sec. and still yield reversals, but only by careful regulation of the fogging light. Light shocks, varying in duration from 1/15,000 sec. to 1/500 sec., were tried, and it was found that with increase of duration of light shock the reversals become weaker. Time also plays an important *rôle* in connection with the fogging light; apparently in the case of very brief and intense light shocks comparatively intense fogging light of short duration will yield reversals, but in the case of shocks of say 1/1,000 sec. duration, the fogging light must be feeble and of long duration in order to obtain reversals. Some experiments upon the fifth type of reversals were also tried, in which it was found that an ordinary exposure was converted to a light shock effect by bichromate of potassium and nitric acid; that is to say, if after treatment the plates were exposed to candle-light, the original images developed reversed. The effect of Röntgen rays is also interesting. These rays prevent the reversal of the spark images by subsequent candle-light—in other words, they negative the Clayden effect. Röntgen-ray images themselves, even those impressed with long and weak exposures, can be reversed by exposure to lamp-light. If a plate be exposed simultaneously to the action of candle-light and Röntgen rays, the latter inhibit the action of the former. Pressure marks were also investigated, and finally it was found that the stimuli can be arranged in the following order: Pressure marks, Röntgen rays, light-shock and lamplight, an impression of any one of them can be reversed by subsequent exposure to any other following it in the list, but in no circumstances by any one preceding it. [See also Abstracts Nos. 717 (1903) and 1036 (1904).] E. C. C. B.

1002. *Absorption of Light by Mercury and its Vapour.* **R. J. Strutt.** (Phil. Mag. 6. pp. 76–78, July, 1903.)—Light from a paraffin lamp was observed through a column of mercury vapour 3 m. long contained in an iron gaspipe closed at the ends by mica. The light was compared with a beam of the same intensity reflected from the same lamp and passing through air. No absorption of light by the mercury vapour was observed. The vapour was saturated and at the boiling-point of mercury. Taking the experiment as accurate to 10 per cent., it may be concluded that the coefficient of absorption for the light of a paraffin lamp cannot exceed 0·0003. A comparison was made by transmitting light through a very thin film of solid mercury. The estimated thickness of the film was 6×10^{-8}. This transmitted $\frac{1}{5}$ of the light of the paraffin lamp. Hence the coefficient of absorption of solid mercury is 3×10^7. On dividing the coefficients of absorption of the liquid and solid by the respective densities the quotients are, for the liquid 0·03, and for the solid about 2×10^6. A stratum of mercury vapour containing not less than 2×10^7 times the mass of mercury per sq. cm., contained in a film of solid mercury, would be required to produce the same effect in absorption of light as that due to the film. J. J. S.

1003. *Luminous Radiation of the Nernst Filament.* **L. W. Hartman.** (Phys. Zeitschr. 5. pp. 1–6, Jan. 1, 1904. Phys. Rev. 17. pp. 65–90, Aug., 1903. Communication from Randal Morgan Laboratory of Physics, University of Pennsylvania, April 10, 1903.)—The author has carried out a spectrophotometric study of the radiation from the Nernst filament under varying current density. A Kirchhoff spectrometer was adapted for the purpose, the prisms being replaced by a Rowland plane grating having 14,437 lines to the inch. As standards for comparison an acetylene flame and a Hefner candle were used, the filament itself being run on alternate current. The figures obtained by comparison with these standards are given. The author considers that at normal current density the radiation from the Nernst lamp is relatively rich in the longer waves of the spectrum, but there is no marked selective radiation. The light intensity increases with age; it is richer in the long waves, but poorer in the short ones than that from acetylene, but the two radiations become somewhat similar with increased current. The luminous radiation is on the whole very similar to that from incandescent old lime. W. H. S.

1004. *Refraction at a Cylindrical Surface.* **A. Whitwell.** (Phil. Mag. 6. pp. 46–58, July, 1903. Phys. Soc., Proc. 18. pp. 488–501; Discussion, p. 501, Nov., 1903.)—The position and forms of the focal areas produced by refraction at a cylindrical surface are described. The light diverges from or converges to a point. For the plane containing the radiant point and the axis of the cylinder the locus of the intersections of the real refracted rays is given by—

$$y^2 = \frac{x^2}{a^2(\mu^2 - 1)} \left\{ \frac{(ax + ra - a^2)^2 - (\mu\, \overline{a - r}\; \overline{x - a})}{(x - a)^2} \right\},$$

where r is the radius of the cylinder and a the distance from the radiant point to the axis. Many special cases are discussed, and drawings are given. For the case of the other plane of symmetry, viz., the plane containing the radiant point and normal to the axis of the cylinder, it is found that the focal line is an arc of a circle, and the focal area is contained between two such arcs. J. W. P.

1005. *Dispersion Apparatus of High Resolving Power.* **O. Lummer** and **E. Gehrcke.** (Phys. Techn. Reichsanstalt, Wiss. Abh. 4. pp. 63–84, 1904.)—A comparative discussion of the different kinds of dispersion apparatus, viz., prismatic, diffraction, echelon, and interference spectroscopes. The first section deals with the resolving power, *e.g.*, for q prisms of base p the resolving power for wave-length λ' is $\lambda'/\delta\lambda' = 1000\,pq(\lambda/\lambda')^3$, where λ is the mean wave-length. For a diffraction grating with p openings the resolving power in the spectrum of the qth order is pq, and in an echelon grating of p steps, each producing a path-difference q, $\lambda/\delta\lambda = pq$. In a second, theoretical, section the general case is treated in which a number of parallel coherent rays are incident on a given number of equal, equidistant, parallel slits, and emerge as a series of rays of which the path-difference for homologous points increases arithmetically, and the amplitudes of the rays form a geometric series. The intensity of these at the point where they are focussed is then calculated. In the third section the efficiency of the apparatus and its limits are discussed, tables being given of the capabilities of each instrument for varying dimensions of the optical parts. For example, Table I. shows that a silvered glass plate 3 mm. thick can separate the 144th part of the distance between the D lines, *i.e.*, it has the theoretically possible efficiency of a Rowland grating of 110,000 lines with a spectrum of the first order. The step grating has a smaller resolving power but much greater "visibility," the latter quantity being measured by the number of homogeneous waves present in the light, and separately perceptible by means of the apparatus. G. E. A.

1006. *Double Refraction in Jelly.* **G. Quincke.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 7. pp. 258–265, Feb. 4, 1904.)—In continuation of a previous paper [see Abstract No. 2190 (1901)], jellies are investigated with respect to their property of doubly refracting light, it being stated that liquid jelly consists of invisible foam cells with liquid foam walls, and stiff jelly of invisible foam cells with stiff foam walls. Prismatic bars taken from a cooled gelatine solution, exhibit, under bending, double refraction which increases with time, with dilatation, and content of gelatine. For equal dilatations bent and stretched bars show about the same double refraction. Prisms, spheres, and cylinders of jelly (Leimgallerte), on swelling in water, show transient positive double refraction on the outside and negative double refraction on the inside, the optic axis being normal to the surface. When shrinking takes place in air, alcohol, or glycerine, the phenomenon is reversed, the negative double refraction appearing on the outside. The magnitude of the transient double refraction depends on the speed of swelling or shrinking. If the change takes place very slowly, no double refraction is observed. In viscous substances the double refraction disappears after a certain period called the "time of relaxation." Vegetable membranes and animal tissues are swollen or shrunken foam masses or jellies with visible or invisible foam cells. The walls of these foam cells are stiff in the dilated condition when the organic substances show permanent double refraction. [See also Abstract No. 398 (1904).] G. E. A.

1007. *Effect of Intensity upon Velocity of Light.* **T. E. Doubt.** (Phys. Rev. 18. pp. 129–134, March, 1904.)—According to Ebert the velocity of propagation is to nearly one-millionth part independent of its intensity when this is varied in the ratio of 1 to 250. Confirmatory results are here obtained. The apparatus used is similar to that of Michelson and Morley for the investigation of the motion of the medium upon the velocity of light. Paths in air, water, and carbon disulphide are employed. The following table shows, for pairs of beams in different ratios of intensities, the change of velocity that could be (and was not) detected.

Ratio of Intensities.		Length of Optical Path.	Change of Velocity that Might be Detected.
Air	1·290000	460 cm.	124 cm. per sec.
Air	1·290000	1000 „	57 „ „ „
Water	1·250000	593 „	100 „ „ „
Water	1·43000	1289 „	42 „ „ „
Carbon disulphide	1·43000	707 „	80 „ „ „

J. W. P.

1008. *Cosmical Function of the Green Plant.* **C. Timiriazeff.** (Roy. Soc., Proc. 72. pp. 424–461, Dec. 19, 1903. Croonian Lecture.)—The idea (Draper) that photochemical processes in the green leaf were a function of the luminosity depended on the use of an impure spectrum; and to use a pure spectrum the gasometric appliances have had to be on a very reduced scale. Then Herschel's law applies, that the photochemical reaction is induced by those rays which are absorbed by the substance undergoing a change. Latent images of the chlorophyll spectrum, formed of starch and developable by iodine, may be formed in leaves previously deprived of starch; but blue and violet produced very little effect, perhaps owing to the simultaneous formation and dissolution of starch. If the quantity of carbonic dioxide reduced by chlorophyll in the yellow half of the spectrum be 100, the effect of the blue half (on the other side of λ = 550μμ) is 54. The production of starch in the blue half is shown to follow the same law; and the reduction of CO_2 as well as the production of starch is due to the rays absorbed by chlorophyll. Chlorophyll has no absorption-bands in the infra-red, and there is no chemical effect there. Chlorophyll is bleached by light in the absorption bands only. In promoting the decomposition of CO_2, chlorophyll acts as an "optical sensitiser" and is itself reduced to a protochlorophyllin which is immediately re-converted into chlorophyll by oxygen under the action of light. This protochlorophyllin (which can be made by acting on chlorophyll with nascent hydrogen) exists in the living plant and can be isolated if the plant be reared and solutions from it made in absolute darkness. Chlorophyll also acts as a chemical sensitiser, an absorbent of the products of reaction; and as an optical sensitiser it is special in respect that its maximum of absorption corresponds to the maximum of energy in the spectrum (about 666μμ). Other sensitisers promote maxima of photographic effect towards the redward side of their absorption bands, where the energy of the incident rays is greater; but with chlorophyll the maxima of absorption and of energy coincide, and the chemical process stands in relation not only to absorption but also to the energy of the rays absorbed. The maximum effect is obtained at about one-half of direct sunlight; below this intensity the effect is roughly proportional to the intensity. Part of the energy absorbed by chlorophyll is spent in vaporisation. The chlorophyll is in so thin a layer in a leaf (about $\frac{1}{10}$ micron) that sunlight would raise it to 6,000° C. in one minute, apart from re-radiation; but the radiant energy seems to be transformed into chemical work without passing through the stage of high temperature. When the CO_2 is broken up the radial energy then applies itself to evaporation. Excessive brightness does not therefore conduce to assimilation beyond a certain point, and may dry up the plant; whence the arrangements whereby plants present the edges of their leaves to the sun or otherwise impede evaporation. Since only half of noon sunlight is utilised in assimilation, a long day with a low sun is of greater importance than a shorter day with a higher sun. A. D.

1009. *Optical Rotation of Lactose.* **H. Trey.** (Zeitschr. Phys. Chem. 46. pp. 620–719, 1903. Polytechnikum, Riga, Aug., 1903.)—The following table shows the influence of temperature on the (constant) specific rotatory power of lactose.

	(1) 4·5 gm. hydrate in 100 c.cm. water.		(2) 9 gm. hydrate in 100 c.cm.		(3) 8·559 anhydride.
	$[\alpha]_D$ (hydrate).	$[\alpha]_D$ (anhydride).	$[\alpha]_D$ (hydrate).	$[\alpha]_D$ (anhydride).	$[\alpha]_D$ (anhydride).
0°......	50·23	52·86	53·01	58·78	55·44
10°......	—	—	—	—	54·86
20°......	50·00	52·64	52·23	54·96	54·39
40°......	48·66	51·23	51·23	53·92	53·44
60°......	47·55	50·06	50·46	53·10	51·93
80°......	46·23	48·66	48·34	50·88	49·94
110°......	—	—	46·89	49·35	48·89

The velocity-constants of the mutarotation of solutions containing 4·59 lactose hydrate per 100 c.cm. of aqueous solution were: at 25°, 79·70; at 20°, 67·27; at 0°, 7·85. A similar solution of lactose anhydride (of which the rotatory power increases with time), gave the velocity-constant at 25°, 56·81. In each case the velocity-constant was slightly less (79·42 and 56·01) when the concentration was halved. The following table shows the retardation of the mutarotation by adding alcohol to the aqueous solution, the temperature in each case being 25°, and the velocity-constant in aqueous solution being taken as unity.

(1) Lactose hydrate, 2·25 gm. in 100 c.cm.:
MeOH (1 vol.) H_2O (3 vols.), 0·2455;
EtOH (1 vol.) H_2O (3 vols.), 0·2202.
(2) Lactose anhydride, 2·1375 gm. in 100 c.cm.:
EtOH (1 vol.) H_2O (3 vols.), 0·4610;
EtOH (1 vol.) H_2O (1 vol.), 0·2292;
EtOH (3 vols.) H_2O (1 vol.), 0·1196;
MeOH (1 vol.) H_2O (3 vols.), 0·5813;
MeOH (1 vol.) H_2O (1 vol.), 0·3973;
MeOH (3 vols.) H_2O (1 vol.), 0·2367.

The retardation is in each case approximately proportional to the amount of the alcohol added. Similar figures are given for the retardation produced by the addition of acetone. The following table shows the accelerating influence of acids at 0° on the mutarotation, the value of the velocity-constant in neutral solution being taken as unity :—

		HCl.	H_2SO_4.	$C_2H_2O_4$.
Lactose hydrate	N/10 acids........	2·36	2·22	2·01
„ „	4N/10 „	6·78	5·07	3·20
„ anhydride	N/10 „	2·27	1·85	—
„ „	4N/10 „	6·60	4·67	—

Weak acids produce a correspondingly reduced acceleration.

Sodium hydroxide and ammonia in dilute solution very greatly accelerate the mutarotation, but in concentrated solutions the alkalies after producing an instantaneous mutarotation give rise to a gradual fall of specific rotatory power to about 20°, as the result of some secondary interaction. A number of alkaline salts and some supposed neutral salts produce an acceleration of the mutarotation, but sodium chloride is without influence; the acceleration of the mutarotation may be used, like that of glucose, as a sensitive test for feeble basic properties. Cane-sugar and raffinose produce little if any acceleration. Finally, it was found that a mixture of 2·2500 gm. lactose hydrate with 4·2750 gm. anhydride in 100 c.cm. of aqueous solution did not exhibit mutarotation. T. M. L.

1010. *Magnetic Rotation in Selective Absorbents.* **L. H. Siertsema.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 749–752, Jan., 1904. Proc., March, 1904. Phys. Lab. Leiden.)—The author compares his results with those of Bates [see Abstract No. 308 (1904)], and of Schmauss [see Abstract No. 69 (1904)]. He investigates experimentally the error in estimating the position of an absorption band produced by a quartz plate in light from K_3FeCy_6 solution and from water. The values found agree to $1\mu\mu$, whereas Bates' theory would require a considerable difference. Hence the large rotations obtained before appear to be justified. [See also Abstract No. 542 (1903).] H. H. F. H.

1011. *Polarisation of Long Waves by Wire Gratings.* **H. du Bois** and **H. Rubens.** (Deutsch. Phys. Gesell., Verh. 6. 2. pp. 77–82, Jan. 30, 1904. Physikal. Institut der techn. Hochschule, Charlottenburg, Jan., 1904.)—The partial polarisation of light when passed through a narrow slit, discovered by Fizeau in 1861, was verified in 1892 by du Bois, who showed that wire gratings cause, with increasing wave-length, at first an increase of polarisation at right angles to the direction of the slit, then a maximum, a decrease to zero, and afterwards a polarisation in the same direction as the slit, getting stronger as the wave-length increases. Long infra-red waves obtained by reflection from four fluorite or five rock-salt surfaces are passed through a platinum wire grating and concentrated on a thermopile. The transparency of the grating for rays in which the direction of polarisation is at right angles to that of the grating wires (Q*s*) and when these two directions are parallel (Q*p*) is given in the table as a fraction of the incident intensity.

Wave-length.	Q*s*.	Q*p*.	$u^2 = \frac{Qs.}{Qp.}$
5μ	0·198	0·248	0·80
$25{\cdot}5\mu$	0·230	0·365	0·63
$51{\cdot}2\mu$	0·332	0·738	0·45

The rapid decrease of u^2 with increase of wave-length is as expected from the electromagnetic theory. G. E. A.

1012. *Hertz's Grating Experiment with Visible Radiation.* **F. Braun.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 4. pp. 154–167, Jan. 21, 1904.)—By passing a Leyden jar discharge through a fine wire placed on a glass plate, a layer of metallic particles is obtained in which there are fine strips running out perpendicular to the wire. In the depositions thus made, places are found which are darker in polarised light when the strips are parallel to the direction of the light vibration than when perpendicular. Photographs showing this effect are reproduced. Behaviour the converse of the above has been noted in gold and platinum preparations. Examined microscopically by Siedentop, a preparation was found to consist of a number of particles distributed irregularly, and between these a uniform clear field not resolvable into particles, but exhibiting the characteristic phenomena of grating polarisation and apparent double refraction. [See also preceding Abstract.] G. E. A.

1013. *Half-shade Elliptical Polariser and Compensator.* **D. B. Brace.** (Phys. Rev. 18. pp. 70–88, Feb., 1904.)—A mathematical consideration of the problem is first given, and arithmetical cases are dealt with to investigate the sensibility and general conditions. The sensibility is found to compare very favourably with that of other systems. The arrangement of the apparatus is as follows: A support carrying the polarising and analysing nicols was arranged so that the various elements of the different systems to be compared could be inserted in the path of the rays. Immediately after the polarising nicol came the compensator, then the sensitive strip, then a vertical graduated circle upon which could be mounted any plate to be compared, then a vertical strip of crown glass (13 × 2 mm.), upon which was cemented a cover for receiving weights, then a horizontal glass strip for receiving flexure, then a micrometer screw carrying two horizontal wires, then a space 30 to 50 cm. long, in which could be inserted the other pieces to be compared, lastly the analysing nicol, circle, and short focus observing telescope. Descriptions of readings are given. J. W. P.

1014. *Magnetic Rotation of Polarised* N*-rays.* **H. Bagard.** (Comptes Rendus, 138. pp. 565–567, Feb. 29, 1904.)—The *n*-rays from a Nernst lamp are refracted through an aluminium prism, and eight distinct beams are observed in the dispersed radiation, the refractive indices of glass for the latter being calculated at 1·56, 1·77, 1·89, 2·03, 2·09, 2·22, 2·63, and 2·90.

Blondlot's results for aluminium show that all these rays travel $1\frac{1}{2}$ times as fast in aluminium as in glass. The rotation observed in a field of 52 Gauss produced by a horseshoe electromagnet varied from 45° 10′ to 12° 30′ for the eight rays on passing through 2 cm. of aluminium, and from 54° 30′ to 21° 30′ for the same thickness of carbon disulphide. A ray of white light under the same circumstances would have been rotated about 4′. G. E. A.

1015. *Absorption Spectra of Nitric Acid of Various Concentrations.* **W. N. Hartley.** (Chem. Soc., Journ. 83. and 84. pp. 658–666, June, 1903.)—This paper contains the results of photographic measurements of the absorption spectra of nitric acid in concentrations varying from 89·6 per cent. (density at 15°, 1·490) to 20·31 per cent. (density at 15°, 1·127). The strongest acid examined (1·490) exhibits an extremely short spectrum, which elongates considerably on dilution. The spectrum of 72·57 per cent. acid (density 1·432) is longer than that containing 20·31 per cent., but it shortens on dilution. With acid of density 1·420 or 69·80 per cent. a slightly shorter spectrum is transmitted, which is still further shortened by dilution. From this point onwards until the acid is diluted with 14 molecules of water (20·31 per cent. HNO_3) the spectra transmitted are practically the same, but the diluted acids transmit spectra which, although shorter, increase in length. There can be no doubt but that dilution alters the constitution of nitric acid of sp. gr. 1·432 and that the effect is the opposite of that observed with silver nitrate solution. [See Abstract No. 1365 (1903).] It must be assumed that in strong nitric acid the acid molecule is either polymerised to $n\,HNO_3$ or exists as a compound of the nature N_2O_5, H_2O. Acid of density 1·490 may be regarded either as a mixture of N_2O_5, H_2O and H_3NO_4 or as a compound $H_3N_3O_9$, H_2O. Weaker solutions of the acid probably contain hydrates. From experiments on the action of nitric acid on lime the author concludes that the concentrated acid contains two different substances, one of which reacts with lime, whilst the other does not. T. H. P.

1016. *Ultraviolet Spectra of Ortho, Meta, and Para Compounds.* **R. Magini.** (Note I. Accad. Lincei, Atti, 12. pp. 87–95, July 19, 1903. Note II. Accad. Lincei, Atti, 12. pp. 260–267, Oct. 4, 1903.)—The author has studied the ultraviolet absorptivity of solutions of the bivalent phenols (pyrocatechin, resorcin, hydroquinone); of ortho, meta, and para oxybenzoic acids; of ortho, meta, and para amidobenzoic acids. The phthalic acids were examined as far as possible, but not completely, on account of the difficult solubility of terephthalic acid. The results are given in the form of tables and curves for the ultraviolet absorption of layers of solutions, 1 cm. in thickness. It appears that (1) all the compounds studied show a high degree of absorption; (2) they show almost always well-marked absorption bands which become displaced towards the luminous end of the spectrum when a carboxyl group or an amino group takes the place of hydroxyl; (3) the introduction of a second carboxyl into the chain appears to nullify the increased absorption and the displacement of the absorption bands, caused by the first carboxyl group; (4) the isomers examined may be arranged in order of increasing absorptivity as meta, ortho, para; this especially applies to absorption in the extreme ultraviolet as observed in very dilute solutions; (5) the absorptions of ortho and meta compounds, though distinct, are analogous, so that they present, for instance, the same maxima and minima; the absorptions of para compounds are much greater than and markedly different from those of the isomers. [See also next Abstract.] D. H. J.

1017. *Ultraviolet Spectra and Stereochemical Isomerism.* **R. Magini.** (Accad. Lincei, Atti, 12. pp. 297–304, Oct. 18, 1903.)—The author has examined the absorptivity of a number of stereoisomers for ultraviolet rays. The substances selected were asparagines (dextro and lævo), the tartaric acids, malic, and fumaric acids. The asparagines gave identical absorption spectra, as did the tartaric acids ; malic and fumaric acids, however, which contain the double bond, have absorption spectra distinctly different, though of the same order of magnitude. [See also Abstract No. 771 (1904).]

D. H. J.

1018. *Ultraviolet Spectra of Tautomeric Compounds.* **R. Magini.** (Accad Lincei, Atti, 13. pp. 104–108, Feb. 7, 1904.)—Acetoacetic ether was the tautomeric substance selected for examination. Specimens from Kahlbaum and also from Haën were examined in alcoholic solution and in absence of solvent. These specimens gave identical ultraviolet spectra in solution with all thicknesses of liquid examined. The spectra, too, were the same for strata of the two undissolved specimens 0·085 cm. in thickness. A slight difference was observed with layers of undissolved liquid 1 cm. in thickness, but the difference is ascribed by the author to differences in the degree of purity of the specimens, as similar differences are found in the results for one and the same specimen according to whether it has been freshly distilled or kept for some time. [See also Abstracts Nos. 1013 (1903) and 771 (1904).] D. H. J.

1019. *Spectrophotometric Study of Fluorescence.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 18. pp. 122–123, Feb., 1904. Abstract of a paper presented at the meeting of the American Physical Society, Dec. 30, 1903.)—Lommel and others have called into question Stokes's law of fluorescence, namely, that the wave-length of the fluorescent spectrum is always longer than that of the exciting light. Lommel pointed out that there is for certain fluorescent bodies an unmistakable overlapping of the regions in the spectrum occupied by the exciting waves and by the fluorescent light produced. He also concluded that for this class of bodies the character and composition of fluorescence are independent of the wave-length of the exciting source. The authors have applied spectrophotometric methods to the study of the phenomenon of fluorescence, and have succeeded in getting data from which intensity curves can be drawn. They draw the following conclusions : First, that not only is Stokes's law inapplicable in the case of these substances, but fluorescence can be excited by light, the wave-length of which is greater than that of the maximum of the fluorescent spectrum. Secondly, that the curves of fluorescence when excited by white light, by nearly monochromatic light of mean wave-length 5246, 4940, and 4650 tenth metres, were identical as regards the position of the maximum, which in all cases was located at 5170 tenth metres. The shape of the curves indicates complete independence between the character of the exciting source and of the fluorescence produced. E. C. C. B.

1020. *Flame Spectra of the Alkali Metals.* **C. de Watteville.** (Comptes Rendus, 138. pp. 346–349, Feb. 8, 1904.)—The spectra of the flames was obtained by spraying a solution of the metallic salt, and feeding the spray by an air-draught into the air-holes of a Bunsen burner. The principal and subordinate series of the alkali metals are then seen, but in different portions of the flame. If, by means of a lens of short focus, a small image of the complete flame be thrown upon the spectroscope slit, it will be seen that the spectrum is divided into three parallel bands. In the lowest, corresponding to the blue cone, all the lines are visible; at the upper limit of the middle band the two subordinate series stop, while the top band shows only the lines of the principal series. This is somewhat similar to that previously described by Lenard for the arc discharge [see Abstract No. 533 (1904)] and by Semenov for the spark discharge [see Abstract No. 1428 (1903)]. The author considers that these effects are due to temperature differences in the flame, which cause dissociation of the element. E. C. C. B.

1021. *Spectrum of the Arc.* **C. de Watteville.** (Comptes Rendus, 138. pp. 485–486, Feb. 22, 1904.)—When self-induction is introduced into the circuit of a spark discharge, certain changes are observable in the spectrum; generally speaking the spectrum approaches that of the arc. The author, wishing to attribute these changes and also those of certain flame spectra observed by him [see preceding Abstract] to temperature effects, made some observations upon the effect of varying the temperature of the arc by varying the amount of current flowing. This he carried out by means of Fleming and Petavel's method [Phil. Mag., April, 1896], and found certain changes in the relative intensity of the lines of certain spectra. The author concludes by remarking that the differences observed can only be considered to be of a pure thermal order, since the experimental conditions involved an arc with direct-current, in which only the current and hence the amount of heat developed was varied; there can, therefore, be no question of forced vibrations or of electrical constraint of the atom. [See also Abstract No. 892 (1903).] E. C. C. B.

1022. *Law of Distribution of the Lines of Band Spectra, and the Spectrum of Nitrogen.* **H. Deslandres.** (Comptes Rendus, 138. pp. 317–323, Feb. 8, 1904.)—The author has made a complete measurement of the frequencies of the lines in the second group of bands in the positive spectrum of nitrogen, using a 4-in. plane grating with a concave mirror of 2·5 m. focus. The measurements were made in the third, fourth, and fifth orders by comparison with Rowland's tables. It was then found that the band at $\lambda = 3577$ contains more than twice as many lines as had been previously measured; further, each band is composed of six or seven series of rays, each series forming, as the author pointed out some time ago, an arithmetical progression. A diagram is given in the paper of the band at $\lambda = 3577$, showing the arrangement of the lines in six series. The third series is striking in appearance because it consists of pairs of rays of unequal intensity, and the more intense ray is alternately the more and the less refrangible of the two. The third series may therefore be considered to consist of two series, each of which consists of alternating strong and weak lines—a close analogy with the negative glow band spectrum of the same gas. The series obey a general formula $N = A(m + p/q)^2 + c$ where A, p, q, and c are constants; for example, the fourth series is given by the equation $N = 27955{\cdot}750 + 0{\cdot}2061943(m + 3/4)^2$, and the other series by very slightly differing values of the constants. In conclusion the author re-states his well-known law, and points out that it only applies to bands which have series of less than fifty rays. In exceptional cases, when the series have a greater number than fifty rays, it will be found that considerable systematic errors occur, which show that more complex relations are involved. E. C. C. B.

1023. *Secondary Radiation from Gases subject to Röntgen Rays.* **C. G. Barkla.** (Phil. Mag. 5. pp. 685–698, June, 1903.)—Various gases were exposed to Röntgen rays and the secondary radiation was studied. The following are the experimental results: (1) All gases subject to Röntgen rays are a source of secondary radiation. (2) The absorbability of the secondary radiation is (within the limits of possible error) the same as that of the primary radiation producing it. (3) For a given primary radiation the intensity of secondary radiation is proportional to the density of the gas from which it proceeds. (4) The secondary radiation is not due to re-combination of the ions. As the primary and secondary radiations only differ appreciably in intensity, the radiation proceeding from gases subject to Röntgen rays is probably due to scattering of the primary radiation. J. J. S.

1024. *An Undescribed Form of Radiation.* **F. Sanford.** (Phys. Rev. 17. pp. 441–459, Dec., 1903.)—When the terminals of the secondary winding of an induction coil are connected to the plates of an air condenser, the condenser plate connected to the kathode gives off a peculiar form of radiation into the condenser field whenever the current is interrupted in the primary coil. If a spark is allowed to pass between the knobs of the secondary the radiation is given off from both plates. The author's view, that the radiation is undulatory and of the nature of ultraviolet light, probably generated by molecular collisions, having been questioned by many physicists, the experiments described were made to clear up the subject. As a result it is found that the rays may be reflected, refracted, and polarised like ordinary light. When they fall upon bodies a secondary radiation is given off which resembles the original radiation in character. Rock salt, quartz, and glass, are most transparent to the rays. Alcohol is very transparent to the radiation which is absorbed strongly by carbon disulphide, hence its wave-length would seem to lie between $250\mu\mu$ and $400\mu\mu$, and the fact that flint glass is very transparent to it would make it seem probable that its wave-length must be greater than $330\mu\mu$. J. E.-M.

1025. *Character of the Radiation from Ordinary Metals.* **E. F. Burton.** (Phys. Rev. 18. pp. 188–191, March, 1904. Abstract of paper presented before the meeting of the American Physical Society, Dec. 30, 1903.)—The conductivity of air contained in a cylinder was measured when the cylinder was surrounded by screens of water of various thickness, the cylinder being immersed successively in tanks of three sizes. The decrease in conductivity was approximately proportional to the thickness of the water screen which was in the three experiments 10·5, 24, and 60 cm. When the pressure in the cylinder was reduced it was found that the conductivity was almost exactly proportional to the pressure. These facts indicate that the remaining conductivity is probably due to a penetrating radiation and not to one easily absorbed. J. J. S.

1026. *Theory of Radio-active Phenomena.* **R. Schenck.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 1. and 2. pp. 37–43, Jan. 7, 1904.)—Attention is called to the fact that ozone is produced from oxygen electrically and also yields gaseous ions during its decomposition; the process is therefore regarded as a reversible operation, analogous to gaseous dissociation, in which ozone is produced from oxygen and gaseous ions, and breaks down again into these constituents when decomposed; equations are given to represent this view. The production of ozone in contact with radio-active substances is similarly explained as due to the interaction of gaseous ions with oxygen; the production of the ions by the radio-active substance is, however, compared with the dissociation of calcium carbonate into lime and carbon dioxides, in which at constant temperature there is a constant pressure of gas until the whole of the material is dissociated; it is thus suggested that there will be a constant concentration of gaseous ions in contact with a radio-active solid. This equilibrium will, however, be disturbed by the formation of ozone and other secondary actions. The concentration of the ions (analogous to vapour tension) will vary in different substances and reaches a maximum in the case of radium salts; as heat is liberated during the operation of the ions, the tension of the ions must decrease as the temperature rises. It is suggested that it might be possible to reverse the process of ionisation at high temperatures and large concentrations of the ions, and that the radio-active materials may have been produced under these conditions by volcanic action. Autoxidation is regarded as a result of chemical processes in which gaseous ions are produced, so that oxygen becomes converted into ozone; hydrogen peroxide is frequently produced, and this behaves similarly to ozone, liberating emanations which act upon a photographic plate through a layer of aluminium. The oxidation of phosphorus is also discussed from the same point of view. [See also Abstract No. 296 (1904).] T. M. L.

1027. *Radio-activity in the Atmosphere.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 5. pp. 11–20, Jan. 1, 1904.)—An account of further investigations on the radio-activity of various kinds of earth, and the widespread radio-active properties of atmospheric air, especially in confined situations and over clay soil. The conclusion reached is that this widely observed radio-activity is due to infinitesimal quantities of radium which are contained in the earth's crust, and find their way into various springs and mineral waters and also into the atmosphere in the neighbourhood of these radium-containing formations. The greater radio-activity of the air over inland districts compared with that over the sea or at places on the sea-coast, is very noticeable.

J. J. S.

1028. *Study of Phosphorescence.* **A. Dahms.** (Ann. d. Physik, 13. 3. pp. 425–463, Feb., 1904. Abstract from Leipziger Habilitationsschrift. Physik. Inst. d. Univ., Leipzig, Feb., 1903.)—The effect of heat rays in extinguishing phosphorescence, discovered by Seebeck, was re-discovered by E. Becquerel, who showed that under the action of the yellow-red rays, a re-glowing takes place before the extinction. A spectrographic investigation is made dealing with the effect of rays, extending from 3μ to ultraviolet, on plates of phosphorescent material such as Balmain's paint, strontium and zinc sulphides, and fluorspar, all in the form of finely grained powders. The phosphorescence is caused by white light, and the plate is immediately, on being removed from the white light, subjected to spectrum rays for one minute. To avoid the re-glowing, another minute is allowed to elapse before a photographic plate is applied to the phosphorescent plate for one minute. The effect of the different parts of the spectrum in extinguishing phosphorescence is shown in the reproductions illustrating the paper. No essential difference was found between rays which excite and rays which quench phosphorescence, since, by altering the conditions of the experiment, the one kind may be changed into the other. An effect was found with zinc sulphide which is neither a thermal nor a phosphorescent one. Whilst the other substances examined showed, under the action of a certain radiation, a re-glow which preceded the extinction of the phosphorescence, no re-glow was observed in the zinc sulphide, and the latter is quenched in a much shorter time than the other substances. G. E. A.

1029. *Phosphorescence of Organic Substances at Low Temperatures.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 18. pp. 120–122, Feb., 1904. Abstract of paper read before the meeting of the American Physical Society, Dec. 30, 1903.)—This is a preliminary note giving some qualitative results obtained by the authors before entering upon quantitative measurements. In all, 120 substances, chiefly organic compounds of definite composition, were tested. The substance under examination was placed in a glass or porcelain dish in a dark room, and covered with liquid air, poured directly upon it. It was then exposed to light from a spark between magnesium terminals, and the phosphorescence, if any, was observed after the spark was stopped. By interposing glass between spark and substance, the observer could determine whether the phosphorescent effects were due to ultraviolet rays or not. The authors have found that many of the bodies tested have their power of phosphorescence increased by cooling, and some are apparently unaffected by cold, as regards phosphorescence; but among the organic substances studied no example was found of a body, phosphorescent at ordinary temperatures but having this power diminished or destroyed at low temperatures. Some examples are given of the different effect of cold upon different substances. The Röntgen rays seem much less effective than light in producing luminescence at low temperatures. The authors have not been able, so far, to develop any law connecting luminescence with chemical composition. W. C. H.

1030. *Action of Radium on Glass, Quartz, and Other Bodies.* **N. Georgiewski.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 1b. pp. 1–7, 1904.)—Glass is known to be blackened under the influence of radium rays, the same phenomenon being observed in the case of quartz. The colouration produced by radium disappears not only under the influence of a heating, but at ordinary temperatures as well. The author has investigated, by a photometric method, the absorption of glasses and of quartz coloured by radium rays, as well as its diminution with time; the diminution can be represented by a logarithmic curve. The author describes his experiments made on quartz, mica, gypsum, and other bodies, showing the alteration of the optical properties of these materials under the influence of radium rays. On mica being placed between crossed nicols, an alteration in the chromatic polarisation in the portion which formerly was exposed to the action of radium rays is seen, this alteration disappearing as soon as the specimen is heated. Gypsum and fluorspar show the same alterations of the optical properties, but are not blackened under the influence of radium rays. A. G.

1031. *Experiments on the Emanation from Radium Bromide.* **T. Indricson.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 1b. pp. 7–13, 1904.) —To show the diffusion of the emanation from radium bromide, a long tube was used, the internal surface of which was coated with a layer of sidotblende (zinc sulphide). On connecting the apparatus with a test tube containing a solution of radium bromide, luminescence was found to appear and to be propagated throughout the tube. On repeating Ramsay's experiments, the author found that the yellow helium line did not coincide with the yellow lines of the spectrum given by the emanation, but was situated between the two yellow lines of the emanation. On the serpentine communicating with the tube being dipped into liquefied air, a strengthening of the lines corresponding to the helium line was noted in the spectrum of the emanation, while between the two yellow lines above referred to, a third line, coinciding with the yellow line of helium, appeared. The lines of helium do not exist in the spectrum given by the emanation of a freshly prepared tube, but only appear afterwards. On observing the gases set free on the dissolution of radium bromide, it was observed that the helium lines did not appear as long as the spectrum tube preserved its phosphorescence in the dark. After four days this phosphorescence would disappear, and the lines of helium could be noted in the spectrum. A. G.

1032. *Emanation from Radium.* **J. A. McClelland.** (Roy. Dublin Soc., Trans. 8. 6. pp. 89–94, Feb., 1904.)—An account of experiments undertaken to test whether the emanation given off by radium carries an electric charge or not. The conclusion reached is that the emanation is not charged. The radium atom certainly gives off positively charged particles—the α-rays. The emanation particles cannot be what remains of the atom after the emission of one or more α-rays, because in that case it would be negatively charged. The atom must have parted with an equal negative charge, either by the emission of negative particles, or in some other way. J. J. S.

1033. *Radio-activity of the Atmosphere.* **S. J. Allan.** (Phil. Mag. 7. pp. 140–150, Feb., 1904.)—Various experiments on atmospheric radio-activity are described. In some of these the radio-active properties of a long copper wire were tested after the wire had been exposed for different periods in the air and kept at a constant negative potential of about 20,000 volts. The general results of the experiments indicate that the excited activity from the atmosphere behaves in many respects like the radio-activity from thorium and radium. It contains an easily absorbed α-radiation and a more penetrating β-radiation. The difference in the rates of decay of the excited activity obtained under different conditions seems to point to the fact that the radio-activity of the atmosphere is of a very complex nature. J. J. S

1034. *Emanation of Actinium.* **A. Debierne.** (Comptes Rendus, 138. pp. 411–414, Feb. 15, 1904.)—Further investigation of the behaviour of actinium confirms the author's previous observations. [See Abstract No. 86 (1904).] The energy of the emanation, measured by the ionising effect in gases, decreases regularly from the moment of production of the emanation, falling to one-half its original value in 3·9 sec. The most characteristic property of the emanation, however, is its capacity of producing induced radio-activity on solid bodies. Whilst the ionising energy of the emanation diminishes regularly from the instant of its disengagement, the activating energy at first increases rapidly, passes through a maximum and only diminishes regularly after a certain time. This regular decrease is then identical with that of the ionising energy, falling to one-half in 3·9 sec. There are two distinct effects, probably due to two kinds of centres of energy, the one producing ionisation in gases, probably by emission of Becquerel rays, the other provoking induced radio-activity on solid bodies, and those which activate succeed those which ionise. The following is the course of the phenomenon: The centres of emanation, produced directly by actinium, ionise gases but do not give induced radio-activity; they disappear gradually, according to the law of diminution, by half in 4 sec., transforming themselves into activating centres; these latter do not ionise gases, and themselves disappear progressively whilst producing induced radio-activity on solid bodies. If the activating centres disappear more rapidly than the ionising centres, the law of decrease of the activating effect must become the same at the end of a certain time as that of the ionising effect. The decrease of the induced radio-activity due to actinium is regular, and falls to half value in 40 min. Actinium compounds also give off another emanation, in very small quantity, whose law of decrease is very slow, diminishing by half in many days. This may proceed from another radio-active element different from actinium. J. J. S.

1035. *Disappearance of Induced Radio-activity.* **P. Curie** and **J. Danne.** (Comptes Rendus, 138. pp. 683–686, March 14, 1904.)—Referring to their former paper and the curves there given, showing the results of their experiments [see Abstract No. 1875 (1903)], the authors find that in the limiting case, when the body has been exposed for a long time to the action of the emanation, the intensity I of the radiation whilst the surface is de-activating is given as a function of the time t by the difference of two exponentials.

$$I = I_0\left(-(k-1)e^{-bt} + ke^{-ct}\right), \text{ where}$$
$$k = 4{\cdot}2\,;\; b = 0{\cdot}000538 = \frac{1}{1860}\,;\; c = 0{\cdot}000413 = \frac{1}{2420}.$$

The results can be interpreted theoretically according to Rutherford's view by supposing that the emanation acts on solid surfaces in such a way as to create a radio-active substance B which disappears spontaneously according to a simple exponential law with coefficient b. In disappearing the substance B gives rise to a new radio-active substance C which itself disappears according to a simple exponential law with coefficient c. If the two substances B and C emit Becquerel rays the total radiation must be of the limiting form. The value of the coefficient k depends on the ratio of the emissive powers of the substances B and C for Becquerel rays. In the particular case when C alone radiates, $K = \frac{b}{b-c} = \frac{0{\cdot}000538}{0{\cdot}000538 - 0{\cdot}000413} = 4{\cdot}3$. Experiment having given 4·2 for this coefficient K, there is a remarkable agreement, and things occur as if the substance B did not radiate but transformed itself into a substance C which alone emitted Becquerel rays. The law of de-activation of a solid surface which has been submitted during a time θ to the action of the emanation of radium is expressed by the formula.

$$I = I_0\left(-\frac{c}{b-c}(1-e^{-b\theta})\,e^{-bt} + \frac{b}{b-c}(1-e^{-c\theta})\,e^{-ct}\right).$$

To explain all the peculiarities of the curves of de-activation, the appearance and disappearance of three successive substances must be supposed, and a similar but more extended formula expresses the phenomenon. J. J. S.

1036. *Photographic Action of Radium Rays.* **S. Skinner.** (Phil. Mag. 7. pp. 288–292, March, 1904. Communicated by the Physical Society.)—The author endeavours by experiment to prove whether the actions of light and of radium on a photographic plate are the same. The developed plate appears to be darkened in a similar way, but no information is available as to the intermediate stages. A different part of the same plate was exposed to radium bromide for times from 30 sec. to 48 hours, and after development the images were compared by a sensitometer. The general result showed that the intensity of the image increased to a maximum, then decreased rapidly, and finally very slowly until no image formed on development. The maximum was reached with Ilford plates in 15 min. with 10 mgm. of radium bromide, and in 7 or 8 min. with 50 mgm. With Lumière plates the maximum was reached in 2 hours. Spark images on a plate are at first obliterated on exposure to radium rays which do not cause as great a density of image as the spark images obliterated. In other experiments a Clayden reversal was obtained by exposure to radium after exposure to electric sparks, and on prolonged exposure a re-reversal was noticed. The author suggests the inclusion of this effect in Wood's series [see Abstract No. 1001 (1904)], provisionally between light-shock and lamplight. L. H. W.

1037. *Röntgen Rays, and the γ-rays from Radium.* **A. S. Eve.** (Nature, 69. p. 436, March 10, 1904.) **E. Rutherford.** (Nature, 69. pp. 436–437, March 10, 1904.)—Experiments were carried out by Eve to find if the more penetrating Röntgen rays after passing through thick metal screens were similar in their action to the γ-rays of radium. The experiments showed that the relative conductivity imparted to gases by Röntgen rays is a function of the penetrating power of the rays employed, and the results obtained approximate to those found for the γ-rays rather than to the high figures previously quoted for Röntgen rays. For Röntgen rays comparable in penetrating powers with the γ-rays the differences in the relative conductivity of gases previously observed with these two kinds of rays to a large extent disappear. Commenting on Eve's experiments, Rutherford points out that all the experimental evidence so far obtained is now in agreement with the view that the γ-rays are very penetrating Röntgen rays which have their source in the atom of the radio-active substance at the moment of the expulsion of the β or kathodic particle. J. J. S.

1038. *New Kind of* N-*rays.* **R. Blondlot.** (Comptes Rendus, 138. pp. 545–547, Feb. 29, 1904.)—There appears to exist a variety of *n*-rays which, instead of increasing the brilliance of a feeble source of light, diminish it. On exploring the least refrangible portion of the spectrum of *n*-rays deviated by an aluminium prism by means of a narrow slit furnished with phosphorescent sulphide of calcium, it was found that the brightness of the slit diminished under the action of the rays, and increased again when the rays were intercepted by a moistened screen. The author by methods similar to those previously described has measured the indices of refraction (varying from 1·004 to 1·041), and the wave-lengths (from 0·003 to 0·0081) of these new rays, which he calls n_1-rays. Certain sources seem to emit n_1-rays chiefly or exclusively. Stretched wires of copper, silver and platinum are examples of such substances. Ethylic ether also, when under forcible constraint, emits these rays according to Bichat. On removal of the constraint the emission of n_1-rays disappears at once. J. J. S.

1039. *Peculiarities of the Action of* N-*rays.* **R. Blondlot.** (Comptes Rendus, 138. pp. 547–548, Feb. 29, 1904.)—When a feebly illuminated surface is looked at *normally*, the action of the *n*-rays is to render it *more luminous.* When the surface is viewed obliquely, almost *tangentially*, the *n*-rays cause it to appear *less luminous.* The effects depend on the position of the observer with relation to the sensitive screen. The action of n_1-rays is inverse to that of the n-rays. They diminish light emitted normally, and increase that emitted tangentially. The effects of sonorous vibrations, of a magnetic field, and of an electromotive force are similarly inverse for a screen viewed tangentially. In all cases the modification experienced by the luminous emission consists in a change of its distribution along different directions comprised between the normal and the tangent plane to the illuminated surface. J. J. S.

1040. *Transparency for* N-*rays*. **E. Bichat.** (Comptes Rendus, 138. pp. 548–550, Feb. 29, 1904.)—The author has verified the values given by Blondlot for the indices of refraction of n-rays, and has tested various substances taken in sheets of greater or less thickness as to their transparency towards the rays of different refrangibilities. The sheets of metal used were placed between the source of the rays and a phosphorescent screen. The substances tried were mostly opaque for certain radiations, whilst transparent for others. Silver in thin or relatively thick layers was transparent for all radiations, but palladium, nickel, and iridium are always opaque. Lead, copper, zinc, gold and glass are opaque for some and transparent for other of the rays. Pure lead is sometimes transparent, but when coated with oxide or carbonate is always opaque. Metal wires are capable of transmitting only those n-radiations for which they are transparent. Mercury even in considerable thickness is transparent to the n-rays from a Nernst lamp. J. J. S.

1041. *Particular Cases of Emission of* N-*rays*. **E. Bichat.** (Comptes Rendus, 138. pp. 550–551, Feb. 29, 1904.)—On observing a Natterer tube containing carbonic acid placed in front of a phosphorescent screen it is seen that the upper part containing gas produces no effect; the action commences at the level of the liquid and increases downwards on the screen opposite the more compressed portions of the liquid. Similar effects are seen with tubes of protoxide of nitrogen and a siphon of sulphurous acid. A tube of CO_2 heated above the critical temperature emits no n-rays. On cooling the tube and viewing a screen near it in the dark, a quick increase of the brightness occurred at the same moment that a mist formed in the tube, showing liquefaction of the CO_2. Liquid air is found to emit n-rays, as also does ozone. J. J. S.

1042. *Contribution towards the Explanation of Blondlot's* N-*rays*. **O. Lummer.** (Phys. Zeitschr. 5. pp. 126–128, March 1, 1904.)—The author repeats his previously published criticisms on Blondlot's experiments [see Abstract No. 553 (1904)] and states that a whole series of changes of the analysing bright surface, described by Blondlot, can be imitated without using any source of radiation. These effects he ascribes to phenomena which occur in the rods and cones of the observer's eye. J. J. S.

1043. *Differences in the Actions of Heat and of* N-*rays on Phosphorescence*. **R. Blondlot.** (Comptes Rendus, 138. p. 665, March 14, 1904.)—Whilst the action of n-rays increases the quantity of light emitted by a phosphorescent screen in the normal direction, it diminishes the amount sent out very obliquely. Heat, on the contrary, causes an increase of brightness in all directions comprised between the normal and the tangent plane. If one-half of a phosphorescent screen be exposed to heat it becomes more luminous than the rest. If instead half the screen is exposed to n-rays from a Nernst lamp its brightness scarcely becomes greater, but if a small object such as a key or piece of metal is now held in front of the screen, its outline is shown very sharply upon it, whilst when placed opposite the half on which the *n*-rays do not fall, its outline is blurred and indistinct. J. J. S.

1044. *Emission of* N-*rays in certain Inhibitory Phenomena.* **A. Charpentier** and **E. Meyer.** (Comptes Rendus, 138. pp. 520–521, Feb. 22, 1904.)—By reflex stimulation of the nerve to a gland the emission of *n*-rays is increased, both at the level of the nerve and at the level of the gland. The same result is obtained by direct stimulation of the inhibitory nerves. Even after the activity of the gland has been paralysed by the injection of atropin, this phenomenon is observed. The emission of the rays from the heart is decreased when the inhibitory nerve (vagus) is stimulated and the organ arrested in diastole, but if the inhibitory action of the nerve is destroyed by atropin, the emission is increased. [See also Abstracts Nos. 552 and 554 (1904).] H. W. P. Y.

1045. *Emission of* N-*rays by Plants.* **E. Meyer.** (Comptes Rendus, 138. pp. 272–273, Feb. 1, 1904.)—Further experiments were made with plants kept for some days in the dark. Radiations were emitted by all parts of the plants. Seeds were sown in a closed box and allowed to germinate in the dark. The plants thus produced, though yellow from the absence of light, emitted radiations similar to those from plants which germinated at the same time in the light. When care was taken to shield the plants from external *n*-rays and from light by enclosing them during their time of germination in a lead box, surrounded by moist paper, the action on a phosphorescent screen was still observed, as also when the plants were grown exposed to light but screened from *n*-rays. [See also Abstract No. 762 (1904).] J. J. S.

1046. *Physiological Action of* N-*rays.* **A. Charpentier.** (Comptes Rendus, 138. pp. 270–272, Feb. 1, 1904.)—On bringing near the left side of the skull, in semi-obscurity, a sheet of tempered steel, an effect was produced over the greater part of the posterior region of the parietal and in the neighbouring occipital region. This effect was manifested by a slight increase in the apparent brightness of external objects. In complete darkness a faint luminous sensation was produced showing for the first time direct nervous excitation by the *n*-rays. On conducting the *n*-rays by the method previously described up to a little plate of copper placed above the seventh cervical vertebra, action on the nervous matter of the spinal column was shown by dilatation of the pupil varying from 0·5 mm. to 1 mm. in different cases. [See also Abstracts Nos. 758 and 1050 (1904).] J. J. S.

1047. *Transmission of* N-*rays.* **A. Charpentier.** (Comptes Rendus, 138. pp. 414–416, Feb. 15, 1904.)—An account of further observations on the apparent transmission of *n*-rays emitted by phosphorescent substances. [See Abstract No. 759 (1904).] When a piece of phosphorescent sulphide is attached to the end of a copper wire and made to glow by burning near it some magnesium, a piece of similar sulphide at the other distant end of the wire becomes bright. The simple approach of phosphorescing sulphide to the initial end of a wire causes an action to be transmitted to the other end, which increases the brilliance of sulphide placed there. On cutting the wire the sulphide at the farther end grows dim; when the ends are again joined the terminal sulphide glows. If an air condenser or Leyden jar is placed in series with the wire the effect is transmitted as with a continuous conductor. This transmission has taken place with wires up to 10½ metres in length. The time necessary for the transmission increases with the length of the conductor. The luminous equilibrium of the screen is established by oscillations of brightness, often very prolonged and having a period of many seconds. On using a string steeped in collodion solution of phosphorescent sulphide of calcium as the transmitting conductor, waves appeared to traverse the latter alternately in opposite senses. J. J. S.

1048. *Action of* N-*rays Recorded by Photography.* **R. Blondlot.** (Comptes Rendus, 138. pp. 453–456, Feb. 22, 1904.)—The action of the *n*-rays, proceeding from a Nernst lamp and from other sources, in causing increased brilliance in a small electric spark has been shown and recorded by the author by allowing the spark first alone and then when under the influence of the *n*-rays to act upon a sensitive photographic plate placed below it. The negatives obtained are reproduced in photogravures attached to the paper and show considerably darker impressions when the spark was subject to the influence of the *n*-rays. J. J. S.

1049. *Action of the* N-*rays on the Olfactory Organs, and Emission of* N-*rays by Odoriferous Substances.* **A. Charpentier.** (Comptes Rendus, 138. pp. 584–586, Feb. 29, 1904.)—The author finds that the *n*-rays have a sensible action on the sense of smell; any source of *n*-rays, on being brought nearer to the nose, increasing the intensity of the odour, as well as extending the limit of distance from which it can be recognised. Various sources of the rays were experimented with, such as the contracted muscles of the thumb, a steel ball in a wooden clamp, and essence of cassia was found to be a good substance for the scent, though similar results were obtained with a large number of other essential oils, ether, ammonia, and acetic acid. The action takes place through aluminium, and it is advisable to place a sheet of this metal near the nose and operate from the other side, to obviate any air currents due to the moving of the source of the rays. The *n*-rays can also affect the olfactory sense when the source of radiation is brought near certain nervous centres such as the glabella and the sinciput, being especially marked in the latter case. The effect of the rays is not solely upon the olfactory organ itself, as a distinct increase in intensity can be perceived when the source of the rays is brought near to a flask containing the odoriferous substance, placed a sufficient distance away for the direct effect on the nose to be indistinguishable. These odoriferous substances themselves also emit *n*-rays. Experiments on the effect of the rays upon the sense of taste seemed to show that also in this case the sensation was strengthened by the radiation, but others on the effect on the hearing gave only rather indefinite results, though a very slight increase was noted. L. H. W.

1050. *Generalisation, through the Nerves, of the Action of* N-*rays Applied at any Point of the Body.* **A. Charpentier.** (Comptes Rendus, 138. pp. 715–717, March 14, 1904.)—The brilliancy of a phosphorescent screen held in the hand is appreciably increased if a movable source of *n*-rays be placed in contact with some other part of the body. The effect is most marked if the part touched be close to a nerve. The source of *n*-rays may be moved along the course of such a nerve until the spinal cord is reached, and then upwards to the level of the medulla oblongata on the same side of the body ; above this the best effect is found to be obtained by applying it to the opposite side and then along that side of the skull. Finally, the maximum effect of all is obtained by applying the *n*-rays to the point on the skull which corresponds with the particular area of the Rolandic cortex which governs the part of the body which is in contact with the screen. The excitation of these points can be made with the same result by the application of faradic currents, but the strength of the current required is so great that the operation is painful. The application of *n*-rays on the peripheral points of the body provoke inversely a visible effect on the screen placed against the corresponding nervous centre, but this is not so marked as in the former method. Lastly, the phenomenon may be produced by stimulation of the point on the other side of the body symmetrically corresponding with that in contact with the screen. [See also Abstract No. 1046 (1904).]

H. W. P. Y.

1051. *Action of the* N-*rays on the Auditory Sensitiveness.* **A. Charpentier.** (Comptes Rendus, 138. p. 648, March 7, 1904.)—The author, referring to his former communication [see Abstract No. 1049 (1904)], has confirmed his experiments on the action of the *n*-rays upon the sense of hearing and finds that they act on the ear itself and not only on certain auditory centres. Sound waves were reflected on to a large sheet of aluminium placed a short distance from the ear. A watch used as a source of sound was placed on the same side of the plate as the ear, the source of *n*-rays being moved nearer to or farther away from the ear, but on the far side of the plate. A distinct increase in the sound was noticeable when the *n*-rays were acting opposite the ear or a little in front of the orifice, probably on the periphery of the acoustic nerve.

L. H. W.

REFERENCES.

1052. *Absorption of Ultraviolet Light by Ozone.* **E. Meyer.** (Deutsch. Phys. Gesell., Verh. 5. 5. pp. 124–128, March 15, 1903. Extract of Berlin Dissertation.)—The author gives the results of an experimental research on the absorption of ultraviolet light of various frequencies by ozone, and confirms Hartley's suggestion that ozone is the cause of the sudden ending of the solar spectrum at about $\lambda = 240\mu\mu$.

J. E.-M.

1053. *Wave-length of* N-*rays Determined by Diffraction.* **G. Sagnac.** (Comptes Rendus, 137. pp. 1435–1437, June 15, 1903. Soc. Franc. Phys., Séances, 3. pp. 173–177, 1903.)—Blondlot considers that the *n*-rays are composite, but the author holds that the additional foci (obtained with a quartz lens) are merely due to diffraction of the one set of rays of mean index 2·942. A theoretical consideration in justification of this is given.

J. W. P.

1054. *Propagation of Light in Tourmaline.* **S. Nakamura.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 6. pp. 343–352, 1903.)—Contradictory results for the value of the refractive index of tourmaline obtained by Viola, de Lépinay, and Wülfing caused the former to conclude that the propagation of light in tourmaline does not follow Huyghens' law for uniaxial crystals. Measurements are made with an Abbé total refractometer on almost colourless Brazilian tourmaline prepared by Zeiss, and these show that $\mu_0 = 1{\cdot}63667$, $\mu_e = 1{\cdot}61934$, and that the propagation of light in tourmaline does not differ perceptibly from the way required by Huyghen's law.

G. E. A.

1055. *Thin Galvanometer Mirrors.* **W. Watson.** (Phys. Soc., Proc. 18. pp. 502–506; Discussion, pp. 506–507, Nov., 1903.)—The author describes a method of making thin galvanometer mirrors by cutting discs out of a rod of fused silica, and polishing one side and platinising that side with a solution (obtainable from Johnson and Matthey) which gives a brilliant permanent surface, and then grinding down the other side till the required degree of thinness is secured. Attachment of this mirror to the magnets is by means of an intervening rod of fused silica. A. D.

1056. *Constants of Coronas.* **C. Barus.** (Amer. Journ. Sci. 16. pp. 325–327, Oct., 1903.)—A note on various constants with tables of results obtained in observations on coronas. J. J. S.

1057. *Combined Development and Fixing.* **T. T. Baker.** (Photographic Journ. 44. pp. 1–6; Discussion, pp. 6–7, Jan., 1904.)—The process of simultaneous development and fixing is discussed, various formulæ for carrying it out being given. Slides shown had been developed and fixed with a solution of water 200 c.cm., hypo 20 gm., sodium carbonate and sulphite each 10 gm., caustic soda 2 gm., and edinol 1·5 gm. The best formula is given as hydroquinone 1·5 gm., potassium metabisulphite 3 gm., caustic potash 10 gm., sodium thiosulphate 20 gm., water 200 c.cm. The presence of thiosulphate does not necessarily increase the speed of development, and it can be present up to 25 per cent. in a developing solution without preventing it from acting. In order to produce successful results it is necessary to employ a caustic alkali as well as, or in place of, an alkaline carbonate. Development is generally completed in less time than usual, whilst fixing frequently takes longer, and in some cases requires a supplementary bath. In the *discussion* it is brought out that the same results are obtained with rapid plates as with lantern plates, a little more caustic soda being used with the rapid plates. G. E. A.

1058. *Phosphorescence and Photographic Plates.* **J. F. Ronca.** (Nature, 69. p. 296, Jan. 28, 1904.)—On "hardening" a film on an Ilford plate which had been subjected to a somewhat protracted development with pyrogallol, and pouring a 7½ per cent. solution of common alum over the plate, the liquid lit up with a pale phosphorescence, not unlike that seen on stick phosphorus, which continued for about 10 sec. The temperature of the room was 23° C. In this and similar cases the plate had not been exposed to ordinary light but to Röntgen rays. [See Abstracts Nos. 763 and 806 (1904).] J. J. S.

1059. *Phosphorescence of Photographic Plates.* **W. J. Clarke.** (Nature, 69. p. 366, Feb. 18, 1904.)—A note pointing out that phosphorescence occurs with mixed pyro and soda solutions without any contact with photographic plate or paper and without adding any other salt. [See also Abstracts Nos. 763, 801, 806, and 1058 (1904).] The phosphorescence is thought to be due to crystallisation taking place in a thin layer of liquid. J. J. S.

1060. *Law of Photographic Development.* **A. Guébhard.** (Comptes Rendus, 138. pp. 491–494, Feb. 22, 1904.)—A series of curves are given which attempt to represent the condition of the photographic plate, film, or paper as a function of the duration of development, the latter being slow, and a case of inversion is examined, which occurs with under-exposure and over-development. G. E. A.

1061. *Velocity of Light in a Magnetic Field.* **J. Mills.** (Phys. Rev. 18. pp. 65–69, Feb., 1904.)—Experiments were made with a Michelson interferometer, in the path of each ray of which was placed a tube of carbon disulphide, surrounded by a current-carrying coil. When the current is about 14 amperes, the difference of phase of the two circular components is about 368°; for 40 amperes, about 1,101°. J. W. P.

1062. *Flicker Photometry.* **H. Krüss.** (Phys. Zeitschr. 5. pp. 65–67, Feb. 1, 1904.)—Some notes on flicker photometry, and the physiological aspects of the question. The author describes a new form devised by himself. It consists of a rotatable disc, mounted between the two lights. On the edge of the disc are mounted reflectors, inclined at an angle of 45° to the axis of rotation and the plane of the disc, and placed alternately with regard to the disc, so that successive reflectors reflect the different sources of light into the eye. W. H. S.

1063. *Ultraviolet Spark and Band Spectra of Sulphur.* **J. M. Eder** and **E. Valenta.** (Ann. d. Physik, 13. 3. p. 640, Feb., 1904.)—In a recent paper Berndt published the wave-lengths of the ultraviolet spark spectrum of selenium [see Abstract No. 536 (1904)], in which he remarked that he could not eliminate the lines due to sulphur present as an impurity. The authors point out that they published in 1898 a complete list of the spectrum lines of this element; they have compared their measurements with those of Berndt, and only find one coincidence, namely, at $\lambda = 4153{\cdot}27$, but they are not able to say whether it is a selenium or sulphur line, as they do not find Berndt's measurements sufficiently accurate; the probability is, however, that Berndt's selenium was free from sulphur. E. C. C. B.

1064. *Optical Activity of Cellulose and its Nitrated Derivatives.* **L. Vignon.** (Bull. Soc. Chim. 31. pp. 105–108, 1904. Soc. Chem. Ind., Journ. 23. p. 202, Feb. 29, 1904. Abstract.)

1065. *Ionisation and Nucleation.* **C. Barus.** (Phys. Rev. 16. pp. 287–299, May, 1903.)—There is a very rapid initial reduction of the ionisation of phosphorus emanation in contrast with the relative persistence and constancy of the nucleation. The whole of the original ionisation vanishes symmetrically, for the nuclei as a whole are neutral throughout. It does not appear that the ionisation lost so soon after the removal of the emanation from the phosphorus surface can ever be restored. J. J. S.

1066. *Radio-activity of Snow.* **S. J. Allan.** (Phys. Rev. 16. pp. 306–310, May, 1903. Communicated to American Physical Society, Jan., 1903.)—About a litre of snow was quickly collected from a thin layer on the surface and evaporated down to dryness in a shallow tin dish. This dish, which before filling with snow had been tested and found to contain no trace of radio-activity, was now able to ionise the air in its immediate vicinity quite strongly. Numerous other tests were made. The amount of activity obtained from a litre of snow was about equal in effect to $\frac{1}{3}$ gm. of uranium. J. J. S.

1067. *Effect of Heat on Excited Radio-activity.* **F. C. Gates.** (Phys. Rev. 16. pp. 300–305, May, 1903.)—An account of experiments carried out in Rutherford's laboratory. From these the author concludes that: (1) Excited radio-activity cannot be destroyed by heat. (2) The active particles are removed from platinum and other wires at a temperature just below white heat, and are transferred unchanged to the surfaces of the cooler solids near. (3) By removing the surrounding gas as fast as the wire is heated a large portion of the active particles may be carried off with it. (4) The removal of the excited radio-activity from the wire is probably due to a volatilisation of the active material. J. J. S.

1068. *Radio-active Gas in Surface Water.* **H. A. Bumstead** and **L. P. Wheeler.** (Amer. Journ. Sci. 16. p. 328, Oct., 1903.)—Gas driven off from water obtained from a spring near New Milford, Conn., of an estimated depth of 1,500 ft. increased the normal air leak about three times when tested with an electroscope. Water from one of the New Haven city reservoirs, which are fed by surface drainage, was found to contain a strongly active gas, which increased the normal air leak twelve times. Gas obtained from water at a depth of 5 ft. was about three times as radio-active as the gas from the surface water. The gases resembled in behaviour the emanation from radium. [See also next Abstract.] J. J. S.

1069. *Properties of a Radio-active Gas.* **H. A. Bumstead** and **L. P. Wheeler.** (Amer. Journ. Sci. 17. pp. 97-111, Feb., 1904. Sheffield Scientific School of Yale University, Dec., 1903.)—This paper gives a full account of extended experiments on the radio-active gas previously referred to [see preceding Abstract] found in the soil and water near New Haven, Conn. From these experiments the gas seems to be identical with the emanation from radium. The density of the radium emanation, as determined by its rate of diffusion, is about four times that of carbon dioxide. The authors were unable to obtain the radio-active gas from mercury recently described by Strutt, and think his results may be due to an impurity in the mercury used. J. J. S.

1070. *Destructive Action of Radium.* **Blythswood.** (Nature, 69. p. 317, Feb. 4, 1904.)—A piece of cambric was used to cover the opening of an ebonite box in which a small quantity of radium was kept. In four days the cambric was rotted away. It was replaced several times with the same result. J. J. S.

1071. *Transmission of* N-*rays.* **E. Bichat.** (Comptes Rendus, 138. pp. 329-331, Feb. 8, 1904.)—An explanation of the transmission of *n*-rays along a wire as being due to a series of successive reflections. This explanation is supported by various observations. For instance, the phenomenon is not altered when the transmitting wire is surrounded by different media. It is only when the matter of the conducting wire or rod is transparent to the rays that they are transmitted. Too sharp an angle in the wire hinders transmission. The rays are refracted out of the material at a sharp corner. Alteration of the surface of the material may stop transmission. The oxidation of the surface of the copper wire, or of a portion of it, causes cessation of transmission. J. J. S.

1072. *Various Radiations.* **J. B. Whitehead.** (Elect. World and Engineer, 43. p. 310, Feb. 13, 1904.)—Comments upon Lummer's criticisms [see Abstract No. 553 (1904)] of Blondlot's experiments, and remarks upon Sanford's work. [See Abstract No. 1024 (1904).] J. J. S.

1073. *Blondlot's* N-*rays.* **J. B. Burke.** (Nature, 69. p. 365, Feb. 18, 1904.)—An account of an attempt to repeat some of Blondlot's experiments which gave a negative result. J. J. S.

1074. *Energy of Radio-active Bodies.* **E. Solvay.** (Comptes Rendus, 138. pp. 495-497, Feb. 22, 1904.)—After considering the difficulty of the energy source of such bodies, the author proceeds to put forward what he calls a theory of "specific potentialisation," according to which there is an "aptness" for certain radiations in certain bodies. The special energy thus originally received, *e.g.*, from solar radiation, is then given out again. J. W. P.

1075. N-*rays Emitted by a Current in a Wire.* **P. Jégou.** (Comptes Rendus, 138. p. 491, Feb. 22, 1904.)—Every wire carrying an electric current is a source of *n*-rays, and a simple way to obtain the rays is to take a Leclanché cell and close the circuit for some time. The liquid accumulates the rays and becomes an energetic source, probably by the rays following the wire (Charpentier) and then storing themselves in the liquid as they do in salt water (Blondlot). G. E. A.

1076. *Action of the Rays Emitted by Phosphorescent Calcium Sulphide on Lactic Fermentation.* **C. Richet.** (Comptes Rendus, 138. pp. 588-590, Feb. 29, 1904.)—The author finds that the velocity of lactic fermentation is at first increased, and after some hours somewhat diminished under the influence of the phosphorescence of calcium sulphide. The possibility that this is due to *n*-rays is suggested, but only tentatively, other experiments being in progress. A. F.

HEAT.

1077. *Expansion of Water at Temperatures between 50 and 100° C.* **M. Thiesen.** (Phys. Tech. Reichsanstalt, Wiss. Abh. 4. pp. 3–32, 1904.)—This is a continuation of the work carried out by the author, Scheel and Diesselhorst, in the Reichsanstalt in 1900, at temperatures up to 56°. [See Abstract No. 479 (1901).] The apparatus used is the same as formerly, except that by automatic temperature regulation one observer less is required. The results are given in the following formulæ, where $P_t = P_{max}(1 - \varepsilon)$:—

$$(1)\ldots\ldots\ldots\ldots\ldots\ldots 1 - \varepsilon = \frac{(t - 3{\cdot}98)^2}{568290} \cdot \frac{t + 343}{t + 72{\cdot}74};$$

or more accurately by—

$$(2)\ldots\ldots\ldots\ldots\ldots 1 - \varepsilon = \frac{(t - 3{\cdot}982)^2}{466700} \cdot \frac{t + 273}{t + 67} \cdot \frac{350 - t}{365 - t},$$

the latter formula introducing the critical temperature. J. B. H.

1078. *Pentane Thermometers.* **R. Rothe.** (Zeitschr. Instrumentenk. 24. pp. 47–53, Feb., 1904. Communicated by the Physikalisch-Technische Reichsanstalt.)—A determination of expansion coefficients of pentane is first of all made by means of four dilatometers, two containing samples of the pentane formerly used [see Abstract No. 67 (1903)], and two containing samples of another supply. The expansion coefficients agree to 0·4 per cent. The method of constructing and calibrating a pentane thermometer to read temperatures down to the temperature of liquid air is next considered, and a table for calibrating it from two fixed points, say 0° C. and —100° C., is given (or 0° C. and —78·2° C., the temperature of a mixture of solid CO_2 and alcohol). The length of time that these thermometers are kept at the temperature of liquid air seems to have no influence on their readings, and one can measure with them temperatures down to —190° C. with an accuracy of ± 0·02°. An electric resistance thermometer is used as standard. J. B. H

1079. *Physical Properties of Metals of the Cerium Group.* **W. Muthmann** and **L. Weiss.** (Ann. d. Chemie, 331. pp. 1–46, 1904. Soc. Chem. Ind., Journ. 23. pp. 255–256, March 15, 1904. Abstract.)—The authors have prepared all five metals of the cerium group by electrolytic means, and in sufficient quantity for an examination of their physical properties. All the metals are harder than lead and tin; cerium is softer than lanthanum, lanthanum and cerium both being softer than zinc; neodymium and praseodymium are harder than zinc, samarium being the hardest of all. Their other properties can be seen from the table :—

Metal.	Sp. gr.	Melting-point.	Heat of Combustion.
Cerium…………	7·0424	623° C.	1603·2 cals. per gm. (to cerium dioxide)
Lanthanum……	6·1545	810°	1602·1 „ (to sesquioxide)
Neodymium …	6·9563	840°	1506 „ „
Praseodymium..	6·4754	940°	1466·8 „ „
Samarium ……	7·7–7·8	—	—

The high heats of combustion show that the metals could be used as reducing agents, as aluminium is used in the thermit process. The alloy of metals of the cerium and yttrium groups, obtained directly from the very cheap residue obtained as a bye-product in the manufacture of thorium nitrate, was found to have a heat of combustion of 1655·5 cals. per gm. L. H. W.

1080. *Powdering of Electrically-heated Platinum Metals.* **L. Holborn, F. Henning,** and **L. Austin.** (Phys. Tech. Reichsanstalt, Wiss. Abh. 4. pp. 87–97, 1904.)—Most of the results have already been referred to. [See Abstracts Nos. 76 and 1395 (1903).] The following table of densities is new :—

Rhodium.........	12·44	Pt 70, Ir 30.........	21·69
Iridium	22·41	Pt 60, Ir 40.........	21·80
Pt 90, Ir 10......	21·54	Ir 90, Ru 10	20·86
Pt 80, Ir 20......	21·63		

The gradual change of thermo-electric force by prolonged heating is shown by the following table :—

THERMO-ELECTRIC FORCE TOWARDS PLATINUM (IN MICROVOLTS).

Duration of heating.	700°	800°	900°	1,000°	1,100°	1,200°	1,300°
	Alloy 90 Pt, 10 Ir No. 3.						
Hours.							
0	—	—	—	14·910	16·490	18·080	19·690
3	9540	11·050	12·560	14·070	15·580	17·130	18·680
6	9730	11·230	12·700	14·230	15·760	17·280	18·810
8	9570	11·040	12·510	14·010	15·500	17·000	18·510
	Alloy 90 Pt, 10 Ir No. 4.						
0	—	—	—	14·960	16·540	18·130	19·740
3	9460	10·960	12·450	13·950	15·450	17·000	18·530
6	9160	10·550	11·930	13·350	14·780	16·210	17·640
8	8840	10·200	11·560	12·930	14·300	15·670	17·050
	Alloy 90 Pt, 10 Rh.						
0		7·230	8·340	9·480	10·670		
3		7·250	8·380	9·510	10·690		
6		7·270	8·400	9·540	—		
9		7·280	8·410	9·540	10·720		
12		7·290	8·420	9·550	—		

T. M. L.

1081. *Specific Heats of Metals and Relation of Specific Heat to Atomic Weight.* **W. A. Tilden.** (Roy. Soc., Proc. 73. pp. 226–227, April 9, 1904. Abstract.)—The author has carried out experiments to determine whether the atomic heats of the elements entering into a compound are preserved in the compound at all temperatures, previous results having shown that with metals of small atomic weight (as in aluminium) the specific heat increased very rapidly with rise of temperature. Tellurium was chosen for the experiment, compounds of tin, silver, and nickel with tellurium being prepared, and two alloys of silver and aluminium. Average specific heats were determined over intervals from the boiling-point of liquid oxygen to 500° C. with the less fusible metals—a range of 680°. The atomic heats were deduced from these readings, and the molecular heats of the compounds calculated from their sp. heats. A comparison of the sum of the atomic heats of the elements present with the molecular heat of the compound at successive temperatures shows a close agreement throughout. Thus Neumann's law is approximately true at all temperatures. The experiments support the view that the sp. heat of a solid depends on the nature of the atoms composing the molecules and is not a measure of the thermal work done in expansion. A discussion of the relations of sp. heat to atomic weight in the solid, liquid, and gaseous states follows. [See also Abstract No. 1389 (1903).] L. H. W.

1082. *Radiation in the Solar System: Its Effect on Temperature and its Pressure on Small Bodies.* **J. H. Poynting.** (Roy. Soc., Phil. Trans. 202. pp. 525–552, Dec. 18, 1903.)—If we know the constant of radiation and either the solar constant or the effective temperature of the sun, Stefan's law enables us to estimate the highest temperature which a surface can reach when it is receiving heat only from the sun. We can also estimate the temperatures of the planetary surfaces and determine the temperatures of very small bodies in interplanetary space. First the author considers the values of the constant of radiation and the solar constant. Allowing for variations in estimations of the solar constant, the effective temperature of the sun is found to lie between 6,200° A. and 7,000° A.; that of space is probably 10° A.; it is shown that for approximate estimates sky radiation may be neglected. An ideal earth, satisfying certain stated conditions, might be expected to have a temperature rather above 289° A.; from this the author shows that the best probable value of the solar temperature is 6,200° A., and this value is then used throughout. The calculations leading to the previous result are now turned the other way round, and taking the temperature of the real and ideal earths as 289° A., the author shows the solar temperature to be 6,200° A. A fully radiating ("black") surface exposed normally to solar radiation at the distance of the earth from the sun has an upper limit of temperature 426° A. From this result the author goes on to show that the upper limit to the average effective temperature of the moon's surface is 371° A.; if the actual temperature be about 297° A. (roughly equal to Langley's estimate), then about three-fifths of the heat received by the moon is conducted inwards; if the moon always turned the same face to the sun, the upper limit would be approached. Next it is shown that the temperature of a fully absorbing spherical solid body of the order 1 cm. in diam. at the distance of the earth from the sun is 300° A. approximately. The first part of the paper concludes with a table of temperatures of surfaces at different distances from the sun. The second part of the paper deals with radiation pressures. After calculating the values of radiation pressure in different cases, the author deals with the radiation pressure between small bodies, comparing it with their mutual gravitation, and gives illustrations. He then proceeds to apply Doppler's principle to the radiation pressure against a moving surface. The results here obtained show that the effect of motion on radiation pressure may be very considerable in the case of a small spherical absorbing particle moving in a stationary medium round the sun. Small particles would be drawn into the sun, even from the distance of the earth, in times not large compared with geological times; dust particles in times almost comparable with historical times. W. S.

1083. *Heat Production of Radium.* **C. Runge** and **J. Precht.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 38. pp. 783–786, July 23, 1903.)—Curie and

Laborde have measured the amount of heat spontaneously given out by radium. [See Abstract No. 1398 (1903).] The authors have compared the output of heat of 57 mgm. of radium bromide with that produced in a platinum spiral by the passage of an electric current. The heat produced was found to be 65 cals. per hour for 1 gm. of radium bromide: or if 257 is assumed as the atomic weight of radium, the heat produced by 1 gm. of radium is 105 cals. per hour. This agrees with Curie and Laborde's result, which gave the output of energy as of the order of 100 cals. per hour.

J. J. S.

1084. *Heat Production of Radium.* **J. Precht.** (Deutsch. Phys. Gesell., Verh. 6. 3. pp. 101–103, Feb. 15, 1904. Phys. Inst. d. techn. Hochschule, Hannover, Jan. 20, 1904.)—The author measured, by means of an ice calorimeter, the heat given out by 34·1 mgm. of radium bromide. The mean value was 2·085 cals. per hour. Thus 1 gm. of radium bromide produces 61·15 cals. per hour, and taking $RaBr_2$ as the formula, and assuming the atomic weight of radium obtained from spectroscopic observations, viz., 258, the output of heat of 1 gm. of radium in the hour would be 98·83 calories. The number is 113·3 cals. if Mme. Curie's number for the atomic weight of radium (225) is taken. The number obtained agrees well with earlier observations. J. J. S.

1085. *Heating Effect of the Radium Emanation.* **E. Rutherford** and **H. T. Barnes.** (Nature, 68. p. 622, Oct. 29, 1903. Phil. Mag. 7. pp. 202–219, Feb., 1904. Paper read before the American Physical Society, St. Louis, Dec. 29, 1903.)—Experiments were undertaken to determine how the heat emission of radium is connected with its radio-activity. The heating effect of 30 mgm. of pure radium bromide was first measured in a differential air calorimeter. The radium bromide was then heated to a sufficient temperature to drive off the emanation, and the latter was condensed by passing through a short glass tube immersed in liquid air, and then the tubes were sealed off. On testing the de-emanated radium the heating effect diminished rapidly during the first few hours, falling to a minimum corresponding to about 30 per cent. of the original value, and then slowly increased again. On substituting the emanation tube in the calorimeter, the heating effect at first increased, for a few hours, to a maximum corresponding to about 70 per cent. of the original heat emission of the radium, and then slowly decayed with the time. The sum total of the heating effect of the radium together with that of the emanation tube was found to be equal to that of the original radium. About 6 per cent. of the emanation in one experiment appeared not to be released from the radium by the heating. The excited activity produced on bodies is due to a deposit of radio-active matter on their surface. The term "excited activity" refers to the radiations from this active matter. It is suggested that the name "Emanation X" may be given to the matter itself, the matter which causes excited activity being produced directly from the emanation. About 75 per cent. of the heating effect observed from radium is not directly due to the radium but to the emanation and Emanation X which it produces from itself. There is a close connection between the variation of the radio-activity of the radium and its rate of heat emission. After separation of the emanation, the activity of the radium falls to a minimum of about 25 per cent. in the course of a few hours and then gradually increases again. At the same time, the activity due to the emanation (observed in a close vessel) increases with the time, on account of the excited activity produced by the emanation on the walls of the vessel.

The curves of recovery of the heating effect of radium and the gradual decrease of the heating effect of the emanation are almost exactly the same as the corresponding curves for the recovery of activity of the radium and the loss of activity with time of the separated emanation. The heating effect of radium appears to be at any time proportional to its activity measured by the α-rays; or the heat emission seems to be an accompaniment of the expulsion of α particles. There is a very sudden drop of the heating effect, observed for both the emanation tube and the radium, after removal of the emanation. The activity drops to 82 per cent. of the maximum value. Thus the radiation supplies about 18 per cent. of the total activity of radium measured by the α-rays. There then follows a fairly rapid decrease for 6 to 8 min., and then a more gradual decay to a minimum of 25 per cent. The initial rapid variation of the excited activity occurs because the first change in Emanation X takes place very rapidly. About 41 per cent. of the total heating effect of radium appears to be due to the emanation together with the first change in Emanation X. The other results indicate that the heating effects accompany the emission of α-rays. The heating effect from the emanation together with that of the active product to which it gives rise is equal to about 75 per cent. of the total heat emission of radium. Since 1 gm. of radium emits heat at a rate of 100 gm.-calories per hour, the emanation from 1 gm. of radium a few hours after its removal radiates heat at the rate of 75 gm.-calories per hour. It is calculated that the total amount of heat derived from the emanation from 1 gm. of radium is about 10,000 gm.-calories. The amount of heat liberated per hour from 1 c.cm. of the emanation would lie between $1{\cdot}25 \times 10^5$ and $1{\cdot}25 \times 10^6$ gm.-calories. This amount from 1 c.cm. would probably be sufficient to raise to a red heat, if not to melt down, the glass tube containing it. The emanation behaves as if it were a gas of heavy molecular weight, and the authors calculate that 1 lb. weight of the emanation while the heating continued would emit an amount of energy between 6×10^4 and 6×10^5 h.p.-days. On the disintegration hypothesis the large amounts of energy involved are derived from the energy latent in the radium atoms, which is released in the successive stages of the disintegration. J. J. S.

1086. *Action of Carbon on Quicklime at the Temperature of Fusion of Platinum.* **H. Moissan.** (Comptes Rendus, 138. pp. 243–245, Feb. 1, 1904.)—An intimate mixture of quicklime and carbon contained in a graphite crucible was heated up in a tube of silica to the temperature of the melting-point of platinum. No trace of calcium carbide was formed after heating for 10 min., showing that lime is not reduced by carbon at the temperature in question. It was noticed that crystals of calcium silicate were formed in the crucible, showing that silica has an appreciable vapour pressure at temperatures lower than its softening-point. At the temperature employed lime does not melt, *i.e.*, it is not reduced by carbon below its melting-point. The melting-point of calcium carbide is higher than that of platinum or of platinum-iridium. [See also Abstract No. 894 (1902) and next Abstract.] T. S. P.

1087. *New Method for the Formation of Calcium Carbide.* **H. Moissan.** (Comptes Rendus, 138. pp. 661–663, March 14, 1904.)—The author has already shown that lime is not reduced by carbon below the melting-point of the former [see preceding Abstract], but that metallic calcium will combine with lampblack at a dull red heat to form calcium carbide. In the present experiments fused calcium chloride, contained in a graphite crucible which forms the positive electrode, is submitted to electrolysis for one hour, using a current of 10–15 amperes at 120 volts; the negative electrode is a rod of graphite. On breaking up the crucible after cooling a crystalline mass is found in the interior, which on treatment with water gives a mixture of hydrogen and acetylene, containing 11·5–14·6 per cent. of the latter. Thus both calcium and calcium carbide are formed during the electrolysis. Better results are obtained if the calcium chloride is mixed with one-quarter of its weight of calcium fluoride, in order to obtain a more fluid electrolyte, and coarsely powdered charcoal is added from time to time. The gas obtained by treating the product with water will then contain as much as 66 per cent. of acetylene. This process could not be used to manufacture carbide of calcium, as, when produced, it is mixed with the fused fluoride and chloride. The temperature at which the reaction takes place is in the neighbourhood of 650° C. T. S. P.

1088. *Distillation.* **E. Charabot** and **J. Rocherolles.** (Comptes Rendus, 138. pp. 497–499, Feb. 22, 1904.)—In continuation of their previous work on the distillation of two non-miscible liquids contained in the same vessel [see Abstract No. 142 (1903)], the authors consider the case where the two liquids are placed in separate vessels and the vapours of one passed into the other. If the vapour of the more volatile liquid is passed into the less volatile, two cases present themselves according as the temperature of the latter is below or above the common boiling-point of the two liquids when present in the same vessel. In the first case the vapour will condense and so heat the two liquids until the common boiling-point is reached. In the second case both liquids distil over approximately according to the equation: $P/P' = M\phi/M'h$, where P is the quantity of the less volatile liquid distilling over in unit time, M its molecular weight, P′ and M′ the corresponding magnitudes for the more volatile liquid, h the pressure to be overcome, and ϕ the vapour pressure of the less volatile liquid at the temperature of the mixed vapours. The relative amount of the less volatile liquid distilling over, *i.e.*, P/P′, can be increased by (1) Increasing its temperature, or (2) Lowering the pressure h (working under diminished pressure). The results of the authors' experiments with water and oil of turpentine are as follows:—

h	Temperature of		P/P′	
	Turpentine Oil.	Mixed Vapours.	Found.	Calculated.
746 mm.	108°	101°	1·6	1·4
38 „	41°	37°	1·7	1·9
22 „	52–53°	48°	5·6	5·4

T. H. P.

1089. *Law of Thermic Constants and Heats of Formation of Barium Constants.* **D. Tommasi.** (Chem. News, 89. p. 123, March 11, 1904.)—From the heat of oxidation of barium (133·4 cals.) given by Guntz [see Abstract No. 824 (1904)] the heat of formation of dissolved barium chloride is calculated to be 198·8 cals. The thermic constant of barium is obtained by subtracting the heat of formation of barium chloride from that of potassium chloride (both dissolved), the value thus arrived at being 2·8 cals. Knowing the thermic constant of barium, it is easy to determine, by the law of thermic constants, the heats of formation of all the soluble compounds of barium. The following are the values (in cals.) thus obtained, together with the experimentally determined numbers :—

	Calc.	Found.		Calc.	Found.
Barium bromide	179·2	179·2	Barium acetate	188·4	188·2
„ iodide	146·6	146·6	„ ethylsulphate...	189·2	189·2
„ nitrate	189·4	189·2	„ glycolate	189·2	189·2
„ perchlorate ...	190·0	190·4	„ benzenesulphonate	188·6	188·8
„ chlorate	189·2	189·0			
„ hydroxide	161·8	161·4	„ picrate	188·6	189·0
„ formate	188·6	188·4			

These results show the validity of the law of thermic constants, which states that, when a metal is substituted for another in a saline solution, the heat given off by each metal is always the same, no matter what the nature of the acid radicle present in the salt. The author proceeds to make use of this law to calculate the heats of formation as yet not determined of other barium compounds. T. H. P.

1090. *Molecular-lowering oj the Freezing-point of Water produced by Concentrated Solutions of Certain Electrolytes.* **H. C. Jones** and **F. H. Getman.** (Zeitschr. Phys. Chem. 46. pp. 244–286, 1903. Chemical Laboratory, Johns Hopkins University, Jan., 1903.)—The occurrence of a minimum value of the molecular depression of the freezing-point has been observed by Arrhenius in solutions of magnesium, calcium, and strontium chlorides, cadmium iodide, and certain of the sugars and allied compounds; by Raoult in the case of calcium nitrate, magnesium sulphate, and copper sulphate, and more recently by a number of American workers and by Biltz. The present communication is a continuation of work already published on the subject, and includes not only freezing-point determinations extending to higher concentrations than those dealt with in the earlier experiments, but also measurements of the conductivity, refractive index, and boiling-point of a number of the solutions. It may be pointed out at once that the conductivity values and the refractive indices are quite normal and that the boiling-points show abnormalities, similar to but less pronounced than those observed at the freezing-point. The solutions examined were hydrogen, lithium, ammonium, sodium, potassium, calcium, strontium and barium chlorides, all of which gave well-defined minima; hydrogen and lithium nitrates, which exhibited minima, and ammonium, sodium, and potassium nitrates, which behaved approximately normally; sulphuric acid which gave a minimum, and ammonium, sodium, and potassium sulphates which gave none; phosphoric acid which gave a minimum, and potassium dihydrogen phosphate which gave none. Of the alkalies, sodium and potassium hydroxide gave minima, as also did potassium carbonate, but the measurements with sodium carbonate were not carried far enough to show a minimum. The results obtained can all be explained by the suggestion put forward by Jones and Chambers, viz., that in concentrated solutions there is combination between the molecules of the dissolved substances and the molecules of the solvent, thus removing a part of the solvent so far as freezing-point lowering is concerned. To explain the conductivity results it is also necessary to assume that there is a certain amount of electrolytic dissociation, together with the hydration, effected in these solutions. The investigation is being extended to non-aqueous solvents, T. M. L.

1091. *Vapour-pressure of Solid Solutions.* **A. Speranski.** (Zeitschr. Phys. Chem. 46. pp. 70–78, 1903. From the Chem. Lab. d. Universität Moskau.)—Determinations were made of the vapour pressure of naphthalene as lowered by the presence of β-naphthol in solid solutions. From these values the molecular weight of the solid can be deduced, the values found at different concentrations (C = mols. β-naphthol per 100 mols. of both constituents) are given in the following table:—

C.	M.	C.	M.
14·6	198	24·6	257
17·3	249	33·6	255

The values are intermediate between those for a single (144) and double (288) molecular weight. In liquid solution M = 157 for C = 18·68. T. M. L.

1092. *Boiling-point of Sulphur.* **R. Rothe.** (Zeitschr. Instrumentenk. 23. pp. 364–369, Dec., 1903. Communication from the Physikalisch-Technische Reichsanstalt.)—Four determinations of the boiling-point of sulphur by means of three high-temperature mercurial thermometers (containing carbon dioxide under 20 atm. pressure and standardised by comparison with a gas thermometer) gave the values—444·66, 444·63, 444·79, 444·82, mean 444·71, agreeing closely with the value 444·7 obtained by Chappuis by correcting the value 445·2° of Chappuis and Harker for expansion of the gas-thermometer vessel. Measurements with a thermal junction gave values 444·6, 445·5, 445·1, mean 445·0°, agreeing with the former value within the limits of this less exact method. The value finally taken is 444·7°. T. M. L.

1093. *Possible Forms of the Melting-point Curves for Binary Mixtures of Isomorphous Substances.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 518–531, Feb. 25, 1904. Translated from Versl. van de gewone vergadering der Wis- en Natuurkundige Afdeeling, Jan. 30, 1904.)—The case now considered is that in which (as ideal conditions) the latent heat of mixing is zero, both in the solid and in the liquid state, so that the solid contains the two components in very much the same proportions as the liquid. The results obtained may also be applied to the boiling-point curves of binary mixtures in which the heat of mixing is negligible, but as the latent heat of evaporation, unlike the latent heat of fusion, is very largely dependent on the temperature, it is necessary that the boiling-points of the two liquids should be close together. [See also Abstracts Nos. 322 and 573 (1904).] T. M. L.

1094. *Variation of Molecular Lowering of Vapour Pressure for Aqueous Solutions.* **A. Smits.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 628–641, March 23, 1904. Translated from Versl. van de gewone vergadering der Wis- en Natuurkundige Afdeeling, Feb. 27, 1904. Chemical Laboratory of the University, Amsterdam.)—From vapour-pressure measurements by means of the micromanometer [see Abstract No. 1398 (1900)] devised by him, the author has previously shown that for dilute solutions, *i.e.*, those having less concentrations than 1 gm. mol. per 1,000 gm. of water, the molecular diminution of the vapour pressure increases with the concentration. This result being directly opposed to that given by freezing-point determinations, the author has made further measurements on the diminution of the vapour pressure of solutions of sodium chloride and nitrate, using the micromanometer of Rayleigh. The results obtained for sodium chloride, together with those previously arrived at, are given in the following table :—

Rayleigh's Micromanometer.		Smits' Micromanometer.	
Concentration of Salt in gm. mols. per 1,000 gm. of H_2O.	*i*.	Concentration of Salt in gm. mols. per 1,000 gm. of H_2O.	*i*.
0·0441	1·96	0·0591	1·79
0·1073	1·81	0·0643	1·76
0·3823	1·740	0·1077	1·72
0·6299	1·742	0·4527	1·70
0·9887	1·771	0·4976	1·70
2·0476	1·822	1·0808	1·723
3·3524	1·917	1·2521	1·730
		1·8228	1·765
		2·1927	1·832
		4·6362	2·032

The two sets of numbers agree very well qualitatively, both exhibiting a minimum value of *i* for a concentration of about 0·5 gm. mols. Introducing into the results of Jones and Getman [see Abstract No. 1090 (1904)] a correction to allow for the non-agreement of the values of *i* calculated from the vapour pressure and from the freezing-point of not very dilute solutions, it is found that the author's vapour-pressure measurements agree qualitatively with those of Jones and Getman on the freezing-point. The cause of the minimum in the value of *i* is probably the formation of hydrates in solution. The measurements of the vapour pressure of sodium nitrate solutions show that these behave qualitatively in a normal way, but that they do not follow Ostwald's dilution law, although solutions of potassium nitrate do so. The deviations for sodium nitrate lie in the direction that K increases with the concentration, which indicates an influence similar to, but in a less degree than, that acting in sodium chloride solutions. T. H. P.

1095. *Cryoscopic Researches on Gaseous Solutions.* **F. Garelli** and **P. Falciola.** (Accad. Lincei, Atti, 13. pp. 110–118, Feb. 7, 1904.)—The authors have determined the freezing-points of solutions of sulphuretted hydrogen, carbon dioxide, acetylene and (to some extent) nitrous oxide, in different solvents. H_2S in aqueous solutions containing from 0·261 to 0·66 per cent. of gas gave molecular weights varying from 25·5 to 31·08, so that there is but little dissociation in such solutions. CO_2 in aqueous solutions of 0·25 to 0·35 per cent. strength gave values of the molecular weight between 38·02 and 39·45; in benzene solutions of 0·16 to 0·73 per cent. strength, the molecular weights found ranged from 39·1 to 51 (mean 44·98). C_2H_2 in benzene gave molecular weights varying from 19 to 28·5 according as the strength of solution varied from 0·165 to 0·608 per cent.; there is considerable difficulty in determining the strengths accurately. The author shows by experimental examples that the cryoscopic method may be used very successfully for determining the strength of saturated solutions of gases and so obtaining the coefficients of absorption of the gases; the coefficients thus found agree closely with those obtained by the ordinary methods. D. H. J.

1096. *Stability-limits of Hydrogen Peroxide.* **W. Nernst.** (Zeitschr. Phys. Chem. 46. pp. 720–724, 1903. Göttinger Institut für Physik Chemie, Nov., 1903.)—According to the observations of Luther, Haber, and Bornemann, a solution of hydrogen peroxide would be stable if the concentration were about N/10^{10}, this being an indication of the very slight reversibility of the action $2H_2O_2 = 2H_2O + O_2$. But as hydrogen peroxide is an endothermic compound, the equilibrium-proportion must be greater at higher temperatures, and it is calculated that at a pressure of 0·1 atmosphere each of water and oxygen, the percentage of hydrogen peroxide would be :—

At 923°	0·00036	per cent.
At 1,140°	0·0032	"
At 1,493°	0·028	"
At 2,154°	0·24	"
At 2,784°	0·66	"

T. M. L.

1097. *Conductivity and Dielectric Constants of some Substances below, and in the Critical State.* **P. Eversheim.** (Phys. Zeitschr. 4. pp. 503–507, June 15, 1903. Ann. d. Physik, 13. 3. pp. 492–511, Feb., 1904. Physik. Institut der Universität, Bonn, Nov., 1903.)—The following curves, which may be regarded as typical, show the variation in specific resistance of a solution of copper nitrate (1·13 per cent. by weight) in liquid ammonia up to and above the critical temperature: the curve (*a*) shows the resistance in the liquid, which was kept uniform by shaking; the curve (*b*) shows the resistance in the

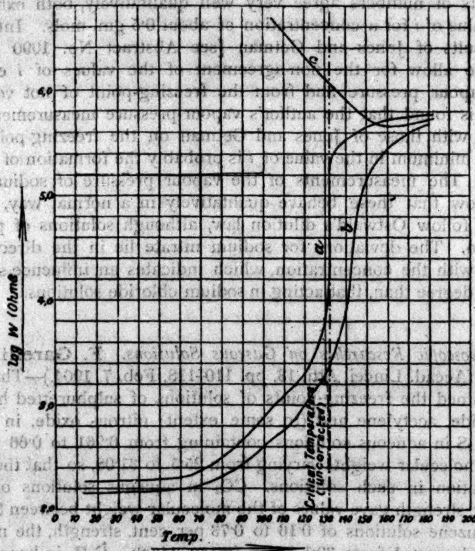


FIG. 1.

liquid, and the curve (*c*) the resistance in the vapour-layer, when the tube was not shaken. The broken vertical line shows the uncorrected critical temperature. At this point a very rapid increase occurs in the resistance of the liquid, but there does not appear to be any abrupt break, and the curve passes on continuously through this temperature. Similar curves are given for ammonia without any added solvent and for sulphur dioxide.

The curves in Fig. 2 show the variation in the dielectric constants of sulphuretted hydrogen (*a*) as measured in the liquid layer, the tube being continually shaken; (*b*) in the liquid layer, and (*c*) in the vapour layer in the unshaken tube; the curve (*d*) shows the variation of the dielectric constant of chlorine in the liquid layer in a well-shaken tube, and the original paper contains similar curves for ether. The broken vertical lines show the critical temperatures for these liquids, and here again there is no abrupt break in the curves at the critical temperature. It may also be noticed that the properties of the two layers do not immediately become identical at the critical temperature, though when the tube is shaken this is approximately the case. [See also Abstract No. 160 (1903).] T. M. L.

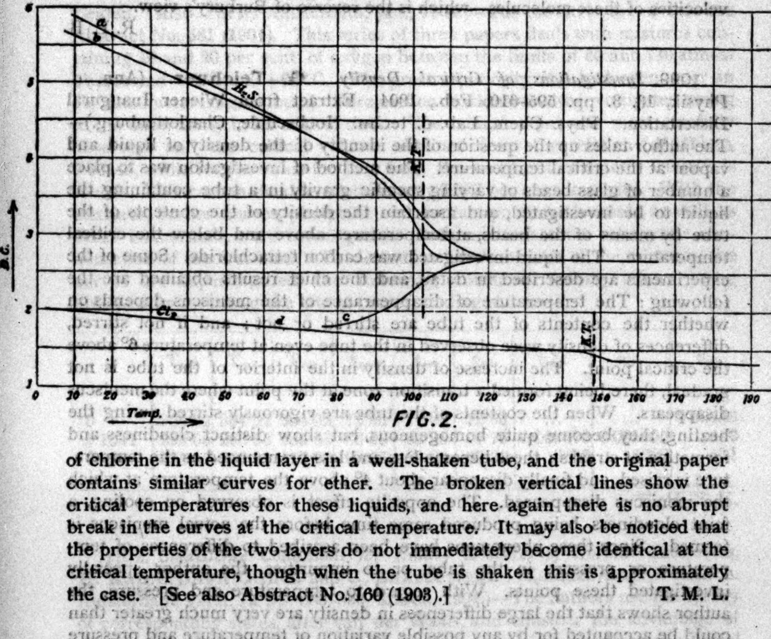


FIG. 2.

1098. *Kinetic Theory of Gases Developed from a New Standpoint.* **J. H. Jeans.** (Phil. Mag. 5. pp. 597–620, June, 1903.)—Instead of regarding a gas as a collection of similar dynamical systems interacting on each other—in the treatment of which the assumption of "molecular irregularity" is generally made, though logically irreconcilable with the continuity in time of the motion of the systems—the author considers the whole gas as a single dynamical system subject to the conditions that (i.) at any instant that part of the total energy of the gas which is accounted for by the intermolecular forces forms an infinitesimal fraction of the whole, (ii.) the conservation of energy is maintained throughout the motion of the gas: he arrives at the same results respecting collision-frequency as are deducible from the above assumption, and also at the Maxwell-Boltzmann law of distribution of velocities. Denoting this distribution by *f*, and taking a function

$H \equiv \iiiint\!\!\iint f \log f \, dx\, dy\, dz\, du\, dv\, dw$, where x, y, z are position co-ordinates and u, v, w velocity-components, he defines as the "normal state" of the gas that for which H is minimum: he then shows that a gas not in the normal state tends to approach that state and that, in examining the physical behaviour of a gas (which depends (i.) on the statistical law of distribution and not on the individual molecules, (ii.) on the values integrated through an interval of time and not on values at any single instant), we may regard departures from the normal state as insignificant. The laws of Boyle, Charles, and Avogadro, and that of equipartition of energy, follow at once, and it further appears that the chance of two molecules having assigned positions is independent of the velocities of these molecules—which is the reverse of Burbury's view.

R. E. B.

1099. *Investigations of Critical Density.* **G. Teichner.** (Ann. d. Physik, 13. 3. pp. 595–610, Feb., 1904. Extract from Wiener Inaugural Dissertation. Phys. Chem. Lab. d. techn. Hochschule, Charlottenburg.)—The author takes up the question of the identity of the density of liquid and vapour at the critical temperature. The method of investigation was to place a number of glass beads of varying specific gravity in a tube containing the liquid to be investigated, and ascertain the density of the contents of the tube by means of the beads, at temperatures above and below the critical temperature. The liquid investigated was carbon tetrachloride. Some of the experiments are described in detail, and the chief results obtained are the following: The temperature of disappearance of the meniscus depends on whether the contents of the tube are stirred or not; and if not stirred, differences of density were observed in the tube even at temperature 6° above the critical point. The increase of density in the interior of the tube is not gradual, there being formed a transition zone at the point where the meniscus disappears. When the contents of the tube are vigorously stirred during the heating, they become quite homogeneous, but show distinct cloudiness and formation of streaks; these become less and less pronounced as the temperature is raised, and finally disappear about 4° above the temperature at which the meniscus disappeared. The opposite effect is observed on cooling, a faint cloudiness being produced some time before the actual meniscus is formed. Since these phenomena have been ascribed to differences of temperature or pressure in the tube, or to impurities, the author specially investigated these points. With regard to temperature and pressure, the author shows that the large differences in density are very much greater than could be accounted for by any possible variation of temperature and pressure in his apparatus. All possible care was taken in the purification of the substance, but nevertheless, differences of density were found even when the temperature was quite constant and higher than the critical temperature. The author gives his results as confirmatory of Traube's hypothesis of gasons and fluidons. He also shows that the behaviour might be explained on the basis of the kinetic theory, because it is quite possible that the movements of the liquid and gaseous molecules might become similar and give rise to interference phenomena, even at temperatures below that at which the two phases become identical.

A. F.

1100. *Abnormal Solubility Lines in Binary Mixtures owing to the Existence of Compounds in Solution.* **H. W. Bakhuis Roozeboom** and **A. H. W. Aten.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 456–462, Feb. 25, 1904. Translated from Versl. van de gewone vergadering der Wis- en Natuurkundige Afdeeling, Jan. 30, 1904.)—The authors discuss the general cases of equilibrium curves between two components capable of forming a compound, dissociated to a varying degree in the liquid phase. Several interesting cases are treated generally, but the paper cannot be given in brief. A. F.

1101. *Isothermals of Mixtures of Oxygen and Carbon Dioxide.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 541–598, Feb. 25, 1904. Translated from Versl. van de gewone vergadering der Wis- en Natuurkundige Afdeeling, Jan. 30, 1904. Communication from Phys. Lab. Leiden. Also Thesis Amsterdam, Jan., 1904.)—For the first part of this see Abstract No. 581 (1904). This series of three papers deals with mixtures containing 10 and 20 per cent. of oxygen between the limits of 60 and 140 atmospheres and —15° and +60° C. The great superiority of a hydrogen- over an air-manometer is again found. Pure carbon dioxide was also investigated owing to the uncertainty in its critical data. The critical point was most carefully observed, and the critical volume obtained from the relation $(dp/dT)_{\text{coëx}}$ 0·00443, while for the value for this from the rectilinear diameter 0·00418 is found. This carbon dioxide contains only 0·027 per cent. impurity. With the mixtures, border curves, plaitpoint and contact-point isothermals, as well as other isothermals, were investigated. Both mixtures show retrograde condensation of the first kind. To determine the constants of the mixtures, the curves are superimposed, the following constants among others being obtained by assuming the law of corresponding states :—

x	$T_{xpl.}$	$T_{xr.}$	$T_{xk.}$	$p_{xpl.}$	$p_{xr.}$	$p_{xk.}$	$v_{xpl.}$	$v_{xr.}$	$v_{xk.}$
0	304·02	304·02	304·02	72·93	72·93	72·93	...	...	0·00443
0·1047	295·03	296·33	285·68	86·60	82·83	67·70	0·003878	0·005005	450
0·1994	285·55	289·31	272·92	99·65	89·20	67·30	3606	5322	431

H. H. F. H.

1102. *Coexistence Conditions for Binary Mixtures of Normal Substances.* **H. Kamerlingh Onnes** and **C. Zakrzewski.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 885–896, March, 1904.)—The authors use the theory of corresponding states, after van der Waals, and consider the advantage of the graphic solution of these problems. A new and improved series of virial coefficients are given. With these the ψ surface for CH_3Cl and CO_2 at —25° C. is modelled, and the binodal and other lines determined. When the vapour tension of the liquid is small, simplified expressions can be used. H. H. F. H.

1103. *Application of the Phase-rule to the Study of the Precipitation of Colloids.* **V. Henri** and **A. Mayer.** (Comptes Rendus, 138. pp. 757–760, March 21, 1904.)—The author gives two different methods of applying the phase-rule to the study of colloidal solutions, in cases where the phenomena of precipitation are reversible. (1) The colloidal solution may be considered as a suspension of fine granules in a liquid; and may be regarded as consisting therefore of two phases. The reversibility of the formation and disappearance of the granules is found in a number of cases in the neighbourhood of the critical point. In the case of two components, the composition of each of the two phases will be independent of the quantity of the components if capillary forces do not play a part; but if surface tension becomes a factor the composition of the two phases will alter. (2) The second method is to regard the colloidal solution as forming a single phase, and to treat the different equilibria as in the case of an ordinary solution. Thus in the case of albumen and copper sulphate one can obtain a system of three phases, crystals of copper sulphate, a precipitate of albumen + copper, and a solution containing albumen and copper sulphate. On altering the proportion of albumen, the composition of the solution alters, and so also the composition of the precipitate. On studying the conditions of precipitation of colloids like albumen, cases are met with which are in contradiction to most of the theories of the precipitation of colloids. Thus, homogeneous mixtures can be prepared of albumen, copper nitrate and water, which give a precipitate on addition of either copper nitrate or of water. A. F.

REFERENCES.

1104. *Thermal Conductivity of Rocks.* **B. O. Peirce.** (Amer. Acad., Proc. 38, No. 23. pp. 651–660, May, 1903.)—The measurements are upon six specimens of rock from the Calumet and Hecla mines. The size of each is about 4 in. thick and 2 ft. square. The method is that previously employed by the author (see Amer. Acad., Proc., Aug., 1898), in which the heat flowing is measured by the melting of ice, and the temperature gradient by thermo-junctions; k is found to range from 0·0031 to 0·0052 for the different specimens. J. W. P.

1105. *Boyle's Law Apparatus.* **W. J. Humphreys.** (Phys. Rev. 16. pp. 364–369, June, 1903.)—A new form by which a variety of different measurements may be taken. The usual assumption of uniformity in cross-section is here avoided. J. W. P.

1106. *Vapour-Pressure Law.* **S. A. Moss.** (Phys. Rev. 16. pp. 356–363, June, 1903.)—The author states in a new form Ramsay and Young's law, and illustrates by curves and tables the uses of this method of statement. J. W. P.

1107. *Electric Furnace Determination of Vapour Densities.* **W. Nernst.** (Amer. Electrochem. Soc., Trans. 3. pp. 75–82; Discussion, pp. 82–84, 1903.)—The author described a method which he had devised for determining vapour densities at temperatures up to 2,200° C., dealt with in Abstract No. 222 (1904). The author pointed out that the method was also suitable for measuring dissociation tensions, boiling-points, and chemical equilibrium at those high temperatures. G. W. de T.

1108. *Vapour Pressure of Liquid Mixtures.* **J. J. van Laar.** (Zeitschr. Phys. Chem. 47. pp. 129–145, Feb., 1904.)—The full title of this paper is: "On the vapour pressure of liquid mixtures, for example, of bromine and iodine, on the assumption of the formation of a partially (in the limiting condition non- or totally) dissociated compound." It contains a mathematical discussion of these cases, not suitable for abstracting. A. F.

1109. *Elementary Proof of the Phase-rule.* **C. Raveau.** (Comptes Rendus, 138. pp. 621–623, March 7, 1904.)—A demonstration of the phase-rule without the use of thermodynamics. A. F.

SOUND.

REFERENCES.

1110. *Effects of Temperature upon Tuning-Forks.* **E. C. Woodruff.** (Phys. Rev. 16. pp. 325–355, June, 1903.)—After considering the work of previous experimenters, the author describes his own apparatus, by which he investigates the temperature coefficient of the frequency from 0° to 200°; the variation of the elasticity coefficient with rise of temperature; and the damping effect of temperature. The method of observing the frequency is the stroboscopic one, and full particulars of the special arrangements are given. It is found that the frequency decreases with temperature rise, but not according to a linear function; that there is a minimum deviation of motion occurring at about 80° for all the forks; and that the elasticity coefficient of steel varies continuously and very nearly linearly.

J. W. P.

1111. *Influence of Amplitude upon Pitch and Decrement of Tuning-Forks and Steel Strips.* **R. Hartmann-Kempf.** (Ann. d. Physik, 13. 1. pp. 124–162, Dec. 29, 1903, and 13. 2. pp. 271–288, Jan. 26, 1904. Abstract of Wurzburg Dissertation.) In a tuning-fork the effect of amplitude a on frequency n follows the form $n = n_0 - (p + \Delta a)a$; and the logarithmic decrement $\lambda = p_1.a$. In steel strips the pitch is affected not only by damping but much more by the shortening of the moment of inertia by deformations, especially at wide amplitudes: thinness of section affects the internal friction by reducing the amount of stretching and compression; and the resistance of the air alters the pitch n and the decrement far more than it does in tuning-forks. Theoretical and experimental development of the subject. Study of the lag (±) of maximum resonance under forced vibrations, under which the resonance vibration may differ in frequency and phase from the exciting pulsation.

A. D.

1112. *Acoustic Shadow of a Sphere.* **Rayleigh.** (Roy. Soc., Phil. Trans. 203. pp. 87–99, with appendix by A. Lodge, pp. 100–110, March 9, 1904. Roy. Soc., Proc. 73. pp. 65–66, Feb. 24, 1904. Abstract.)—The author considers the intensity of sound due to the impact of plane waves on a rigid fixed sphere, and conversely the intensity at a distance in various directions, due to a source of sound on the surface. The paper consists essentially of extensions of the analysis given in § 328 of the author's work on the Theory of Sound. A table of Zonal Harmonics required in the extended calculations has been calculated by A. Lodge, and is contained in the appendix, together with remarks on the methods adopted in calculating and checking.

G. W. DE T.

1113. *Reinforcing Sounds by Flames.* **T. C. Porter.** (Phil. Mag. 7. pp. 283–288, March, 1904. Communicated by the Physical Society.)—Reinforcement of the sound of a tuning-fork, produced by putting the prongs in a Bunsen flame, is due to rarefactions and condensations in the burning flame, particularly in the hottest part of it. The continuous flame of the burner is changed into one which is more or less pulsatile, as is shown by the rotating mirror; and each explosive pulse spreads a disturbance through the surrounding air. A method is described for very strongly reinforcing the sound of a phonograph by making the vibrations affect a coal-gas and air flame: the arrangement being capable of adjustment so as to reinforce either the higher or the lower components more than the others, as may be desired.

A. D.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1114. *Number of Electrons conveying Conduction Currents in Metals.* **A. Schuster.** (Phil. Mag. 7. pp. 151–157, Feb., 1904.)—This paper is in support of the law enunciated as follows: *The number of free electrons in a metal is equal to the number of metallic atoms in the same volume, or exceeds that number not more than three times.* The optical considerations advanced by Drude are reviewed and other arguments brought forward to add further support to the same view of the phenomenon of conduction in metals. As a result of the analysis developed, the author finds the relation $p^2 = 45{\cdot}6\ A^2 C\nu k$; in which p indicates the ratio of the number of electrons to the total number of atoms, A is the atomic volume, C is the electric conductivity, ν a quantity corresponding to the refractive index for transparent bodies, and k is an absorption coefficient. The following table shows the values obtained for p from this equation—

Metals.	A.	C.	νk.	p.
Nickel	6·7	$8{\cdot}03 \times 10^{-5}$	5·94	0·99
Mercury	14·8	1·06	8·58	1·01
Bismuth	21	0·76	6·96	1·11
Cobalt	6·7	9·92	8·54	1·31
Silver	10·3	66·5	1·66	1·46
Copper	7·1	62·6	1·60	1·54
Gold	10·2	48·6	2·06	1·55
Magnesium	13·3	23·7	1·64	1·77
Platinum	9·1	11·0	8·78	1·91
Lead	18·2	5·1	7·00	2·34
Cadmium	13·0	14·6	5·66	2·53
Antimony	17·9	2·8	15·02	2·58
Tin	16·2	7·6	7·71	2·65
Zinc	9·5	17·8	11·62	2·92
Aluminium	10·1	34·3	7·53	3·47

From these results the inference is drawn that metallic conduction may be explained most simply as due to each atom having one, or possibly two or three, negative electrons which are easily detached and follow freely the electric force even for such rapid oscillations as those of light. E. H. B.

1115. *Electrons at the Speed of Light.* **P. Hertz.** (Phys. Zeitschr. 5. pp. 109–113, Feb. 15, 1904.)—A mathematical discussion of the question "Can an electron move at the speed of light?" and in continuation of an article dealt with in Abstract No. 755 (1904). The author finds only finite forces are required to suddenly impart to an electron the speed of light. At any given finite time after the blow the energy, impulse, and force are finite. With time increasing without limit the energy and impulse become logarithmically infinite, while the force asymptotically approaches the limit zero. E. H. B.

1116. *Reversible Galvanic Elements.* **A. Denizot.** (Ann. d. Physik, 13. 1. pp. 193–204, Dec. 29, 1903.)—Starting from von Helmholtz's equation for reversible elements that $E - q = \tau \,.\, dE/d\tau$, and writing τ as a function of any arbitrary temperature scale t, and E and q as functions of t, we get $E(t) - q(t) = \tau \,.\, dE/dt \,.\, dt/d\tau$, whence nat. log. $\tau/\tau_0 = \int_{t_0}^{t} \frac{\frac{dE}{dt}dt}{E(t) - q(t)}$. This shows the relation between the work (±) given out by an indefinitely small reversible cycle to the heat (±) brought to it when an infinitely small quantity of electricity goes through the element at the temperature t, if the cycle is a function of the temperature only and is independent of the element considered. This expression gives an electrochemical scale of absolute temperatures τ. If E and q are linear functions of t, $E(t) = E_0 + \lambda t$, and $q(t) = q_0 + \mu t$, where λ and μ are the temperature coefficients of the e.m.f. E and of the heat change q associated with the chemical reaction (per gm. equivalent). From this we get $\tau = \tau_0 \left\{ 1 + \frac{\lambda - \mu}{E_0 - q_0} t \right\}^{\frac{\lambda}{\lambda - \mu}}$, from which the absolute temperature τ of the element can be found. If $E(t) = q(t)$ for all temperatures, $\lambda = \mu = 0$; and both e.m.f. and heat-change are independent of the temperature. But μ may $= 0$ without λ being equal to 0. Developing the last equation in the form $\tau/\tau_0 = 1 + at + bt^2 +$, &c.; then $\lambda/(E_0 - q_0)$ and $\mu/(E_0 - q_0)$ are the roots of a quadratic equation $\xi^2 - \left(\frac{a^2 - 2b}{a}\right) \xi - 2b = 0$. Evaluation of the different constants from observational data, and their agreement with these, shows that the e.m.f. and heat-changes are linear functions of the temperature t. The absolute temperature τ can be ascertained in relation to the scale t. The ratio of the electric energy and heat developed at the zero of the conventional scale to the electric temperature coefficients is constant. The ratio of the differences between them to the thermic coefficients is constant. The ratio of the electric to the thermic coefficient is also constant. The numerical values of these constants can be ascertained by comparing the absolute temperature τ obtained as above with that on the thermodynamic scale. A. D.

1117. *Motion of Radium in the Electric Field.* **J. Joly.** (Phil. Mag. 7. pp. 303–307, March, 1904.)—A light disk, delicately suspended, and coated upon the one side with a few milligrammes of radium bromide of high activity, exhibits when an electrified body is brought near to it motions very different from what would be observed in the case of an inactive substance. The electrified body, whether positive or negative in sign, *repels* the suspended body if brought up to it *on the side coated with radium*, but attracts it if presented at the naked side. The most probable explanation is that the presence of the charged body induces a charge of opposite sign upon the radium, and repels a charge of like sign to the remote side of the disk. The first (attractive) charge rapidly dissipates, in virtue, chiefly, of the ionising influence of the α-rays; the second (repellent) charge remains to exert a mechanical effect upon the vane. Further experiments supported this view of the cause of the observed phenomenon. J. J. S.

1118. *Charges on Ions.* **J. S. Townsend.** (Phil. Mag. 7. pp. 276–281, March, 1904.)—Comments upon various recent experimental determinations of the charges on ions. The value of e, the charge on an ion in a gas, is probably about 2×10^{-10}. If N is the number of molecules in a gas at 0° C. and 760 mm. pressure and E the charge on a hydrogen atom in a liquid electrolyte, measured in electrostatic units, $N \times E = 1{\cdot}22 \times 10^{10}$. This number is accurately known. If N be taken as 10^{20}, which Kelvin considers the most probable value, $E = 1{\cdot}2 \times 10^{-10}$. H. A. Wilson concludes from his experiments that it may be considered established that e lies between 2×10^{-10} and 4×10^{-10} electrostatic units. The lower value does not differ by more than the factor 2 from the most probable values which can be obtained by both methods. J. J. S.

DISCHARGE AND OSCILLATIONS.

1119. *Action of Canal Rays on Zinc and Aluminium Oxides.* **J. Tafel.** (Ann. d. Physik, 11. 3. pp. 613–618, June 4, 1903. Chemisches Institut, Würzburg, April, 1903.) Reply to above by **G. C. Schmidt.** (Ann. d. Physik, 13. 3. pp. 622–633, Feb., 1904. Physik. Inst., Erlangen, Dec. 1, 1903.) Wien has noticed that the oxides of zinc, aluminium and magnesium, when acted on by canal rays, fluoresce, but that the fluorescence quickly disappears, giving rise to a brownish colouration. Tafel finds that oxygen also is liberated during the fluorescing stage. These actions he attributes to a physical change brought about by the great local pressure developed, in opposition to the view of Schmidt that we are here dealing with a solid solution of some impurity or other in the oxide. Schmidt has now repeated his experiments [see Abstract No. 654 (1903)] with extraordinary care. Al_2O_3 as obtained from various firms gave a red colour. Further purification caused this to disappear, but the addition of a small trace of chromium (1 part in 10,000 is sufficient) gave a vivid red again. The green colour obtained by Tafel and Wien he shows to be due to a trace of copper. The case of zinc oxide was more difficult, but finally it was shown there also that impurity was present in the form of cadmium oxide. R. S. W.

1120. *Ionisation produced by Radium Corpuscles.* **J. S. Townsend.** (Phil. Mag. 5. pp. 698–699, June, 1903.)—From experiments previously described the author concluded that each of the corpuscles given out by radium generates at least 13 ions per cm. in air at 1 mm. pressure. Durack in his observations found the number 0·4 [see Abstracts Nos. 94 (1903) and 142 (1904)]. It is here suggested that the difference in the values is due to the differing thickness of the aluminium through which the radium corpuscles had to pass before reaching the gas. The thickness was greater in the author's experiments, so that the corpuscles passing through the gas would be travelling with diminished velocity and consequently would each produce a larger number of ions per cm. in the gas. J. J. S.

1121. *Noteworthy Observation with Radium.* **E. Dorn.** (Phys. Zeitschr. 4. pp. 507–508, June 15, 1903.)—On Dec. 3, 1902, 30 mgm. of the strongest radium bromide were sealed up in a tube of alkali-free Jena glass, for the purpose of determining the supposed loss of weight by radium salts. On May 27, 1903, six months later, it was desired to open the tube, and for this purpose a triangular file was used. Immediately the file touched the surface of the tube the glass was pierced by an electric spark which was clearly visible in broad daylight immediately in front of the window. The sound was so loud that an assistant who was in the room at the time mistook it for the discharge of a small induction coil. It is suggested that the escape of the negatively charged β-particles and the retention by the glass of the positively charged α-particles had produced a strong positive charge on the inside of the glass, and that ultimately the potential difference (which must have amounted to some thousands of volts) had proved sufficient to pierce through 0·3 mm. of glass. T. M. L.

1122. *Conductivity Produced by Phosphorus.* **F. Harms.** (Phys. Zeitschr. 4. pp. 436–439, May 1, 1903; 5. pp. 93–95, Feb. 15, 1904. Physik. Institut, Würzburg, March 18, 1903, and Jan. 13, 1904.)—It is first shown that the saturation current can easily be reached if the pressure is reduced to 70 mm. of mercury. This is made use of to determine the relation between the amount of phosphorus oxidised and the number of ions produced. By observation of the saturation current over a known time, the number of ions carrying the current is deduced. The amount of phosphorus oxidised is calculated from the alteration of the pressure of the oxygen by which it is surrounded. It requires eight million molecules of oxygen to produce a pair of ions. The author concludes that the whole of these are not used up in the actual production of the ions, but that secondary actions intervene. [See also Abstract No. 661 (1903).] R. S. W.

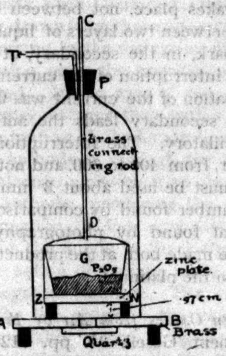
1123. *Electric Phosphorescence and the Action of Radium.* **J. Borgmann.** (Phys. Zeitschr. 5. pp. 104–106, Feb. 15, 1904. Physik. Institut d. Petersburger Universität, Dec. 11–24, 1903.)—Along the axis of a long tube exhausted to several hundredths of a millimetre, a platinum wire is fixed. On connecting the wire to the positive terminal of an induction coil after the working of the coil has ceased, a glow of light is seen in the exhausted tube for 3 to 5 minutes. If the tube is touched with the hand or with an earthed wire, the intensity of the glow is increased at the touched part, and the afterglow when the induction coil has ceased action gains in intensity. If the tube is touched for a moment with the hand during the action of the coil, and, after it has stopped, a capsule with radium bromide is put under the tube, a glow of light shines in the tube and surrounds the wire like a halo. At moments flashes of light are seen outside the glow in different parts of the tube. Under closer observation the light round the wire resembles the appearance in a Crookes spinthariscope. The light decreases on removal of the radium and shines out again when it is brought near. When the wire in the tube is connected to the negative pole of the induction coil, the whole of the surface of the glass of the tube shows phosphorescence which lasts a very short time on stopping the action of the coil. When the capsule of radium is in this case brought near after cessation of the coil's action, the phosphoresence is increased in intensity and lasts a much longer time, the phosphorescence being due to the action of the negative ions. In some similar experiments repeated when the tube was placed in a vessel surrounded with liquid air, the phosphorescence ceased and reappeared again on removal of the vessel from the liquid air, recalling the phenomena due to the condensation of the emanation from radium. It is suggested that in the case of the wire in the tube under electric excitation the atoms get into a state of disaggregation and may give off an emanation resembling that from thorium and radium. [See also Abstract No. 350 (1903).] J. J. S.

1124. *Ionisation Produced by Röntgen Rays at Different Temperatures.* **R. K. McClung.** (Phil. Mag. 7. pp. 81–95, Feb., 1904.)—The experiments were to determine whether a change in temperature of a gas has any effect upon the amount of ionisation produced by a constant beam of Röntgen rays. The considerable experimental difficulties met with have been very successfully overcome. Measurements were first made on air with the pressure constant and the density variable; the ionisation produced was directly as the density, whence it follows that if the density is kept constant there is no effect from temperature. The experiments were next conducted with the density kept constant. For air, carbon dioxide, and hydrogen the ionisation is altogether independent of the temperature. This conclusion is at variance with some results previously obtained by Perrin, but that may be due to the insensibility of the apparatus of the latter. R. S. W.

1125. *Ionisation by Collisions of Positive Ions.* **J. Stark.** (Deutsch. Phys. Gesell., Verh. 6. 3. pp. 104–120, Feb. 15, 1904.)—If ions are produced between two electrodes and removed by an electric field, there will generally be two values of the field for which a sudden increase in the current is noticeable. The lower of these corresponds to the field strength at which negative ions produce other ions by collision, the upper to that for positive ions. One of the electrodes used here is a carbon thread made red hot, which produces positive ions; the kathode is cold. The kink in the current-voltage curve is therefore due entirely to positive ions. As the pressure decreases, this critical voltage decreases until 320 volts is reached; the current after this is a luminous continuous discharge. This value is taken as that which can give to a positive ion sufficient kinetic energy to produce further ionisation. The generalisation is also made that this is always equal to the normal kathode fall, using the same metal and gas. (This from one experiment only). R. S. W.

1126. *Dissociation of Gases by Electric Discharge from Points.* **A. de Hemptinne.** (Zeitschr. Phys. Chem. 46. pp. 13–20, 1903.)—The author has compared the relative effectiveness, under similar conditions, of discharges of positive and negative electricity from points, in producing combination and dissociation of gases at low pressures (not greater than 40 mm.). The apparatus consisted of two similar cylindrical tubes provided with point and plate electrodes, connected in series and back to back, so that on passing a discharge the point would be positive in one tube, and negative in the other. These tubes were connected together in such a way that they could be filled from the same reservoir of gases, at the same pressure, and then isolated from each other, prior to the passage of the discharge, by means of stopcocks. Suitable absorbing materials were placed in the tubes, and any chemical changes produced by the discharge were indicated by corresponding alterations in the levels of the mercury in mercury gauge-pipes communicating with the tubes. Continued discharges were passed from (1) a Wimshurst machine, and (2) a Ruhmkorff coil, and the variations of level in the gauges noted. The negative point-discharge was found to be much the more effective of the two in producing combination in mixtures containing oxygen (such as H and O; CO and O), and to become still more so as the pressure was reduced. It is perhaps slightly more effective than the positive point-discharge, in the synthesis of ammonia, but not appreciably so in the dissociation of ammonia and carbon bisulphide at pressures above 5 mm., though more so in the case of the latter at still lower pressures. There is a close relationship between the appearance and amount of the luminosity in each tube and the chemical effect produced there; and if the chemical effect is greatest in the tube containing the negative point, it is perhaps because the volume of luminous gas there is the greatest. J. D. C.

1127. *Combination of Hydrogen and Oxygen at Low Pressures by Electric Discharge.* **P. J. Kirkby.** (Phil. Mag. 7. pp. 223–232, Feb., 1904.)—Using the apparatus shown in the Fig., small currents were produced by applying a battery p.d. between the plates A B and Z N, the latter being illuminated by ultra-violet light through the quartz window Q. The upper surface of A B was rendered metallically continuous by means of wire gauze. With currents *unaccompanied* by sparking or glow, no appreciable diminution of pressure, owing to the combination of the mixed gases, was observed. The author then proceeded to discover some relation between the fall of pressure and the quantity of electricity passed when the current *was accompanied* by glow and sparking. The electrical quantities were measured by a special high resistance (88,000 ohms) moving coil voltmeter, and the pressure by a McLeod gauge. The pressure of the gases was varied between 1·44 and 6·5 mm., and the p.d. between the plates between 376 and 500 volts. Within the limits of the experiment, the ratio of the fall of pressure per coulomb to the pressure was found to be a function of the ratio of the p.d. to the pressure, the relation being represented by a rising curve slightly concave to the axis of the latter ratio. From the results it is shown that more molecules of water are formed than pairs of ions, which may perhaps be due to the ions separating the neutral molecules of oxygen by collision into uncharged atoms, which then combine with the neutral hydrogen molecules. J. D. C.



1128. *Arc in Metallic Vapours.* **E. Weintraub.** (Phil. Mag. 7. pp. 95–124, Feb., 1904. Contribution from the Research Laboratory of the General Electric Co., Schenectady, N.Y.)—This paper is of very considerable theoretic and practical interest. A great simplification in conditions is obtained by having the arc passing in the vapour of the same metal. Taking mercury arcs first, it is shown that in the process of starting an arc the kathode plays an important *rôle.* A preliminary production of ions in its immediate neighbourhood is necessary. The anode receives the current without any previous excitation. Starting from the recognition of this *rôle*, a new and mechanically very simple method has been devised for an instantaneous starting of the passage of a moderate (100–250) voltage current between the electrodes, no matter how long the distance may be. Thus 120 volts at once struck an arc 55 in. long in one instance given. The method consists in first starting a small auxiliary arc, this arc providing the necessary ions. Other differences between anode and kathode are also studied. Arcs from amalgams as well as from pure alkali metals are investigated. The current from these passes entirely by the mercury when the amalgams and currents are weak. The pure alkalies give scarcely any luminosity. The difficulty of making an alternating current arc has also been surmounted, and, on the basis of this, a theoretically almost perfect rectifier for conversion of alternating into steady direct-current has been developed. R. S. W.

1129. *Aspect of Sparks from a Secondary Coil, using a Wehnelt Interrupter.* **Gagnière.** (Comptes Rendus, 138. pp. 569–571, Feb. 29, 1904.)—The luminous phenomenon takes place, not between the platinum rod and the surrounding liquid, but between two layers of liquid in the interrupter. The interval between the spark, in the secondary, at break and that at make, gives the duration of the interruption of the current. This, as measured, was 0·00075 sec., and the duration of the current was 0·00425 sec. The aspect of the discharge from the secondary leads the author to suppose that it is continuous and not oscillatory. The interruptions per sec. are, with the usual make of interrupter, from 400 to 600, and not 1,000 to 1,500. To obtain the latter value, points must be used about 3 mm. long and 0·3 mm. thick. Even then the larger number found by comparison with a sound of known frequency is double that found by photography. This is explained by supposing that sounds are made both at the production and the disappearance of the gaseous coatings on the platinum. G. E. A.

1130. *Yield of Nitrogen Oxides from Air by the Flame Discharge.* **E. v. Lepel.** (Ber. Deut. Chem. Gesell. 37. pp. 712–719, 1904. Soc. Chem. Ind., Journ. 23. p. 376, April 15, 1904. Abstract.)—The author finds that in the discharge between a copper wire anode and a carbon kathode the immediate neighbourhood of the kathode contains a much larger proportion of nitric oxide than is found near the anode. At greater distances from the anode and kathode the proportions increase and decrease respectively, so that at 5 mm. from the anode the air has more nitric oxide than at 20 mm. from the kathode. The formation of the nitrogen oxides is held to be due to direct electrical action, and not to be solely thermal as Muthmann and Hofer hold. With constant primary voltage and current the temperature of the air surrounding the flame rose as the speed of rotation of the anode increased and as the length of flame was increased. The best yield was at a moderate temperature and frequency, and is also increased by soaking the kathode in solutions of potassium hydroxide, copper sulphate, and other salts. The solution of nitrate and nitrite obtained by neutralising the aqueous solution of the nitrous gases with sodium carbonate can be used as manure, and is as efficient as Chili saltpetre, the conversion of the nitrite into nitrate being unnecessary. L. H. W.

1131. *Disruptive Discharge at very High Potentials.* **J. de Kowalski.** (Comptes Rendus, 138. pp. 487–489, Feb. 22, 1904.)—The author describes some experiments which he has made with three high-tension Thury machines capable of giving 1 ampere at 25,000 volts each; they were coupled in series, thus giving over 70,000 volts. The phenomena observed, though more brilliant, resembled those obtained by Simon and Reich with 5,000 volts. Measurements of the sparking distances between a disc and sphere are given. The conclusions arrived at are as follows: The direct-current, high-tension, low-intensity arc has in general the same characteristics as the alternate-current arc studied by Guye and Monasch [see Abstract No. 649 (1903)]; there is a stable and an unstable zone. The critical zone, however, could not be observed. In the stable zone the relation between length of arc, drop of potential in the arc, and the current can be expressed by a linear equation. The limit of length of the stable arc depends on the current and the terminal p.d. In the unstable zone the direct-current arc has an asymmetric appearance; though nearly steady at the kathode, it jumps rapidly about to quite different parts of the anode. L. H. W.

1132. *Discharges in Air at Normal Pressure, and the Influence of Radium.* **D. M. Sokoltzow.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 2b. pp. 25-38, 1904).—The conclusions drawn from these researches are as follows: Of the two electric emissions occurring in the disruptive discharge in air at normal pressure, the positive emission plays the essential part. This conclusion is borne out by the facts noted. In the case of the point being positive the spark passes at a much greater distance than with a negative point. If both electrodes are identical the putting of the anode to earth will always weaken the spark, whereas if the kathode is earthed, the intensity of the spark is always augmented. The electric emission from the anode is stronger than that given off from the kathode, producing the spark more easily. On investigating the transformation of the slow discharge into a spark, the latter is found to pass from the anode to the kathode. The positive emission is paralysed under the action of radium, while no appreciable action is noted in the case of the negative emission. The influence of radium is the smaller the more point-like the shape of the electrode. If in the spark circuit there are no appreciably strong oscillations, the radium will extinguish a rather long spark, the more easily the greater the surface of the anode. The action exerted on oscillating sparks is of a quite special order; with positive points and negative discs radium is found to impede production of a spark in the neighbourhood and to assist production of a spark at a distance. In the case of the spark-length exceeding a certain limit, any other kinds of oscillating sparks are promoted by radium. [See also next Abstract.] A. G.

1133. *Action of Radium on the Electric Discharge.* **A. Stefanini** and **L. Magri.** (Accad. Lincei, Atti, 13. pp. 268-271, March 20, 1904.)—The authors have carried out experiments on the effect of radium in promoting or hindering the discharge from a spark coil with different spark-lengths and different shaped electrodes. The radium (10 mgm. of radium bromide) was brought near to one of two similar spark-gaps which were of such length that sparking only just took place, and the effect of one spark on the other was screened by a thick sheet of glass. With two point electrodes at small spark distances (< 25 mm.) the discharge was facilitated by the radium. With two spheres the effect depends somewhat on the diameter. At 7-13 mm. sparking distance the discharge is facilitated; at 20-25 mm. no action is noticed; whilst at 25-42 mm. the discharge is impeded. With a disc and a sphere a similar action is observed if the sphere be positive. With the sphere negative no action is observable at small distances, whilst from 8–19 mm. the discharge is impeded. The values at 8 mm. spark distance thus help the discharge if the sphere be positive, and hinder it if negative. With a point and disc similar, but more irregular, results were obtained. Concordant values were obtained when the experiments were repeated with different sized electrodes of different metals. At distances between 11 and 27 cm., with sphere and disc, a hindering action was invariably observed when the radium was brought near the sphere, and no action when approached to the disc. With two spheres at distances 8–23 cm. a hindering effect was noticed when the radium approached the positive sphere, and no action when brought near the negative one. [Compare preceding Abstract.] L. H. W.

1134. *Sensibility of Iron to Electric Waves in Magneto-elastic Hysteresis.* **A. Sella.** (Accad. Lincei, Atti, 12. pp. 340–341, May 3, 1903.)—The action discovered by Rutherford, Phil. Trans., 1897, p. 189, that thin wires magnetised to saturation are partially demagnetised by electric waves, and that by Marconi [see Abstract No. 1060 (1903)] that electric waves passed through a solenoid always produce abrupt variations in the magnetic energy of an iron wire core undergoing a magnetic hysteretic cycle, are found to be general. The same effects are observed when the magnetic hysteresis is due to an elastic deformation by twisting or traction. The author's experiments are also more fully described by **C. Carpini** in Elettricista, Rome, 13. p. 17, Jan. 15, 1904; as also **A. Banti's**; the latter has obtained similar results with nickel. A. D.

1135. *Experiments on Coherers.* **P. E. Robinson.** (Ann. d. Physik, 11. 4. pp. 754–796, June 22, 1903. Extract from Giessen Inaugural Dissertation.)—The author employed single-point coherers, and the measurements made were chiefly of the resistance when a direct current was applied, and the same with electric waves; resonance effects were observed, and the influence of sound. A large number of tables and curves are given embodying the results. The conclusions arrived at are briefly as follows: Before coherence the resistance is chiefly that of an elastic film of badly conducting oxide. With a constant p.d. above the critical p.d. the film no more behaves elastically, and a mechanical injury resulting in metallic contact without subsequent recovery of high resistance takes place. When a direct current is applied the coherer resistance falls to such a value that the p.d. at the terminals has a definite value, called the equivalent-p.d.; application of a greater p.d. produces a further diminution in the resistance until the same equivalent-p.d. is obtained. This p.d. has a characteristic value for each metal. Waves produce the same effect as a direct-current. Fatigue was observed only with waves, probably owing to a strengthening of the film of oxide, caused, in the author's opinion, by the minute sparks in the coherer. Cohering effects can also be produced by sounds and by mechanical means, but not so strongly as by electrical methods. [See also Abstracts Nos. 1136 and 1174 (1904).] L. H. W.

1136. *Theory of Coherers.* **E. F. Huth.** (Phys. Zeitschr. 4. pp. 594–596, Aug. 15, 1903.)—The author refers to the work of P. E. Robinson [see preceding Abstract], who ascribed the fatigue shown by coherers to the strengthening of the film of oxide on the filings by the minute spark produced, such fatigue being practically unobservable when a direct current was used to produce coherence. The author, considering rather that the effect is to be looked for in the dielectric, made experiments to verify this assumption. The method of Eccles [see Abstract No. 2378 (1901)] was employed as being the most suitable. In this the filings are constantly kept in motion by a tapper, and a constant p.d. is applied of such strength that coherence takes place. With the tapper started and the coherer circuit closed a deflection on the galvanometer is obtained which is practically a mean deflection for a number of experiments, being made up of the separate impulses which passed during the coherence periods. Curves are given showing this deflection as a function of the p.d., and were taken—with coherers having, in one case paraffin oil, and in the other, air—as dielectric, at intervals of five to ten minutes. In both coherers fatigue is distinctly shown. A curve from readings twelve hours later showed a pronounced recovery in the oil coherer, a similar recovery being shown by the air coherer when it was carefully opened and fresh air admitted. These results controvert Robinson's observations and assumptions. The author considers that the effect of the waves, or of the constant p.d., is to ionise the dielectric, thus increasing its conductivity, the thinness of the films requiring only feeble forces for this purpose. After the film is once broken down, a levelling of the potentials at the coherer terminals takes place, which, owing to the resistance, produces thermal and mechanical effects, breaking down the oxide layer and welding the particles. This explanation would allow both the contradictory theories of the working of the coherer to be reconciled. [See also Abstract No. 1174 (1904).] L. H. W.

1137. *Electric Waves in Parallel Wires.* **W. B. Morton.** (Phil. Mag. 5. pp. 643–648, June, 1903.) This is a mathematical paper containing further developments of the analysis given in earlier investigations by the same author. [See Abstracts Nos. 516 and 1688 (1901).]—The following are the principal conclusions arrived at: (1) In systems which cause a given amount of retardation in the speed of the waves, the attenuation constant is proportional to the frequency; or, there is a constant logarithmic decrement in running a distance equal to the wave-length in free space of oscillations of the same frequency. (2) When the dissipation of energy in the wires is small, the logarithmic decrement, on running the fraction $1/2\pi$ of a wave-length, is equal to the fractional decrease of the speed of propagation. (3) When the attenuation is rapid, the attenuation constant approaches the value $2\pi/\lambda$, where λ is the wave-length along the wires. G. W. DE T.

1138. *Oscillatory Discharges,* Part II. **A. Battelli and L. Magri.** (Phil. Mag. 5. pp. 620–643, June, 1903.) A continuation of the authors' investigations on condenser discharges. [See Abstract No. 355 (1904).]—Tables are given showing the sparking distance, discharge potential, total energy in the circuit, amount of heat evolved by each discharge in the spark and in the metallic circuit respectively, the sum and the ratio of these two quantities, the resistance of the spark in ohms, and the period. The resistance of the gap appears to decrease with increase of capacity and decrease of induction as noticed by Pierce with the mercury vapour interrupter [see Abstract No. 1140 (1904)], the values for the mean resistance being 0·18 to 0·96 ohm for sparks of from 1 to 5 mm. It follows that with the same capacity and spark-length, the resistance of the gap increases with increase of period. The residual charge after sparking was found to be always less than 1/100 of the initial charge. The results and possible errors are fully discussed and the general conclusions stated, of which the following are reproduced: The period of oscillation agrees with the theoretical value (Thomson), less satisfactory agreement being obtained with short periods (7×10^{-7}, about) owing to the self-induction not being able to be allowed for. The spark resistance increases considerably less rapidly than the length of the spark, suggesting that the resistance is either mostly due to the passage from the electrodes into the surrounding gas, or that the section of the spark augments with increase of length. The sum of the calorific energy expended in the spark and metallic circuit agrees fairly with the value of the energy in the condenser. With cadmium electrodes the sparks are more regular than with non-volatile electrodes (platinum and platinum-iridium). L. H. W.

1139. *Radiations Emitted by a Righi Vibrator.* **H. R. Willard** and **L. E. Woodman.** (Phys. Rev. 18. pp. 1–22, Jan., 1904.)—In these experiments two Righi vibrators were used, one twice the linear dimensions of the other. The receiver was similar to the Klemencik thermo-element, in which an iron-constantan junction was employed. Two strips of copper foil were fastened to the two opposite arms of a wooden cross; to one of the strips an iron wire 0·04 mm. in diameter was soldered, and to the other a constantan wire 0·107 mm. in diameter. These two wires were crossed at the middle of the gap between the copper strips, and passing to the ends of the remaining two arms of the wooden cross were soldered to copper wires leading to the galvanometer. The iron and constantan wires were kept tightly stretched by indiarubber bands. The vibrator and receiver were each placed in the focus of a cylindrical parabolic mirror, and close by the vibrator a control receiver, connected with a second galvanometer, was placed. In experiments made on the measurement of the energy, these linear receivers showed the existence of a fundamental and upper partials. The receiver-lengths for the fundamental and the successive upper partials stand in the relation 1, 2, 3. The wave-length λ and the receiver length l are connected by the relation $\lambda = K(l + a)$, where K and a are constants. The experiments made upon the length of the waves were carried out with a Hull interferometer (Phys. Rev. 28. 1897). It was found that the grating space of the separating surface in this instrument does not affect the wave-length measured. E. C. C. B.

1140. *Cooper-Hewitt Mercury Interrupter.* **G. W. Pierce.** (Amer. Acad., Proc. 39. No. 18. pp. 389–412, Feb., 1904. Jefferson Physical Lab., Harvard University, Dec. 20, 1903.)—The author describes experiments which he has made with the ordinary double pool of mercury type of this interrupter, and considers its applicability to wireless telegraphy. The investigation includes: (1) Measurements of the induction between circuits with the mercury and the air-gap interrupters; (2) resonance effects; (3) oscillations of the Hewitt interrupter; (5) rapidity of recovery; (6) calorimetric measurements of the ohmic resistance of the mercury gap; and (7) determination of the proper vacuum. Under (1), measurements with two closed type circuits 20 m. apart were made, a Fleming oscillation galvanometer being used as indicator. The deflections obtained and the energy communicated between the circuits are about four times as large with the mercury interrupter as with the ordinary air-gap. Under (5), the photographs, in which the sparks were made to trace out a spiral on the revolving film, confirm Simon and Reich's observation that several discharges may occur during a single half cycle of the transformer, the number increasing with decrease of capacity. Thus, with 15,000 volts and C = 0·117 microfarad one or two discharges per half cycle were obtained, while with a small Leyden jar and the same voltage over 200 complete discharges per half cycle were obtainable (in 1/120 sec.), the complete discharges being separated only by about 1/100,000 sec. The recovery is thus very rapid. The discharges with the particular interrupter employed began always at 7,070 volts whatever the capacity of the condensers, the condenser being always left charged to about 1,600 volts, as the discharge was never complete, the residual voltage being sometimes positive and sometimes negative. Under (6), from the expansion of oil in a calibrated calorimeter it was found that the resistance of the interrupter decreases with increasing capacity of the condensers and with decreasing inductance of the discharge circuit, varying from 0·127 ohm for L = 0·000011 henry and C = 0·117 microfarad to 0·598 ohm for L = 0·00142 henry and C = 0·073 microfarad. The author compares these figures with those obtained by Lindemann [see Abstract No. 357 (1904)] and by Battelli and Magri [see Abstracts Nos. 355 and 1138 (1904)]. For the mercury interrupter resistance 0·6 ohm, the value (comparable) by Lindemann for the air-gap is 1·78 ohm. The value obtained by Battelli and Magri, however, for a 2 mm. spark is comparable with that obtained by the author with the same discharge potential. Under (7), the best pressure was found to be 0·02 mm. (before discharge). With pressures two or three times this a brilliant arc was obtained, but only feeble sparks. The paper includes reproductions of the spark photographs. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1141. *Dielectric Constant of Water as related to Temperature and Frequency.* **A. de Forest Palmer, Jr.** (Phys. Rev. 16. pp. 267–278, May, 1903.)—Some observations made during the progress of an investigation "On the Dielectric Constant of Dilute Electrolytic Solutions" [see Abstract No. 874 (1902)] led the author to suspect that the variation of the dielectric constant of water with changes of temperature was greater than would have been expected from the best published values of the temperature coefficient involved. The fact that the frequency of the electrical oscillations was considerably different from that employed in the determinations with which the author was familiar might explain the discrepancy. The results of the present investigation entirely corroborated the anticipated large value of the temperature coefficient for the frequency employed in the previous work, and also show a value in good agreement with published results for frequencies of about 60 cycles per sec. The apparatus and general method of observation were the same as those previously employed [see Abstract No. 874 (1902).] One of the electrometers was kept at a constant temperature by being surrounded with a water jacket, through which water was allowed to flow continuously. The other electrometer was surrounded by a tank containing cracked ice or water, and could be kept at any desired temperature between 0°C. and the temperature of the room. Both electrometers were filled with distilled water of conductivity 7×10^{-6} mhos per c.cm., and complete series of observations between 0·3°C. and 16°C. were obtained with three different frequencies. The two higher frequencies of 10^6 and 3×10^6 periods per sec. were obtained with the apparatus previously used, using Leyden jars of different capacities in the two cases. For the lowest frequency of 60 per sec. the jars were removed, and the parallel wires connected through a variable transformer to a source of alternating current. The author finds that the dielectric constant K for different temperatures is given by the linear equation : $K_t = K_{17}\left\{1 + \beta_{17}(t - 17)\right\}$ and finds the value of β_{17} for the three different frequencies are as follows : 60 cycles, $\beta_{17} = -0{\cdot}0044 \pm 0{\cdot}00028$; 10^6 cycles, $\beta_{17} = -0{\cdot}00624 \pm 0{\cdot}000066$; 3×10^6 cycles, $\beta_{17} = -0{\cdot}007 \pm 0{\cdot}00012$. The close agreement of the values of β_{17} corresponding to frequencies of less than 100 per sec. obtained by Rosa, Heerwagen, and the author, with the values corresponding to frequencies of the order of 10^8 per sec., found by Cohn, Drude, and Coolidge, is strong evidence that β_{17} is independent of the frequency. On the other hand, all determinations with frequencies between these limits have resulted in values of β_{17} that increase numerically with the frequency. Hence it appears that β_{17} first increases to a maximum and then decreases to its initial value as the frequency increases from about 10^2 to 10^8 per sec. The data in hand are insufficient to establish this proposition, and the only definite conclusions that can be drawn from it are that β_{17} is not independent of the frequency, and that further investigation is necessary to establish the exact relation between these quantities. E. C. R.

1142. *Thermo-magnetic Effects with Bismuth-lead Alloys.* **E. van Aubel.** (Comptes Rendus, 136. pp. 1131–1133, May 11, 1903.)—A continuation of the author's experiments on the connection between the Hall effect and thermo-electric power. [See Abstract No. 660 (1903).] In the present experiments alloys of bismuth with small quantities of lead were investigated. The influence of lead is best seen from the following results for the two effects, the values being those due to the field alone, A and B signifying the direction of the magnetisation—

		Effect.	
		Longitudinal.	Transverse.
Bismuth (pure)	(A)	+ 4·96	− 4·30
	(B)	+ 4·23	+ 4·24
Bi 99·43	(A)	− 2·42	− 9·26
Pb 0·57	(B)	− 4·56	+ 9·26
Bi 96·44	(A)	− 5·50	− 7·54
Pb 3·56	(B)	− 7·74	+ 8·33

Longitudinal Effect.—The author concludes that in pure Bi the thermo-e.m.f. is augmented by magnetism. With traces of lead, magnetism diminishes the thermo-e.m.f., until at length the diminution more than counterbalances the increase. Lead giving no effect itself, an alloy exists giving negative and maximum values for the effect. *Transverse effect.*—Traces of lead increase the effect without change of sign. The very different effects produced by lead appear to prove that the two effects are not connected.

L. H. W.

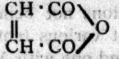
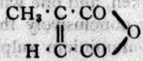
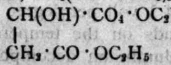
1143. *Influence of Dissolved Gases on Conductivity for a Direct Current.* **S. L. Bigelow.** (Journ. Phys. Chem. 7. pp. 327–347, May, 1903.)—The author gives the results of investigations of the currents obtained in an electrolytic cell with an e.m.f. insufficient to decompose the electrolyte, the currents being measured shortly after the making of the circuit and before the state of "residual currents" is arrived at. Heating the electrolytes to redness is an effectual means of destroying previous polarisation. N/200 sulphuric acid was the electrolyte made use of, and it was found that the presence of dissolved gases (air, oxygen, nitrogen, hydrogen, or carbon dioxide) in it causes considerable increases in the strength of the current. Taking as unity the current obtained with the gas-free acid solution, the currents yielded with the liquid saturated with the above gases are roughly as follows: With air, 19; oxygen, 63; nitrogen, 7; hydrogen, 52; carbon dioxide, less than 1. Direct proportionality does not exist between the amount of a dissolved gas and the conductivity, which makes it probable that only a fraction of the whole takes an active part in the conduction—a condition analogous to partial dissociation of an electrolyte. Increasing 200-fold the concentration of the electrolyte diminishes the conductivity somewhat, although the values for both the aërated and air-free solutions are of the same order of magnitude. With "conductivity" water, the current obtained is rather lower than that with the sulphuric acid, but the increase caused by dissolved air is far less than in the latter case, although carbon dioxide produces a considerable increase. The strength of the current soon after closing the circuit is less the higher the temperature, probably owing to the decreased solubility of gases, whilst after the circuit has been closed for a few minutes the strength of the current is greater the higher the temperature, due most likely to the increase in the rate of diffusion. These results appear to show that dissolved gases conduct, although their conductivity depends in some way, not yet understood, on the presence of an electrolyte which itself takes little or no part in the conduction. T. H. P.

1144. *Theory of the Electrolytic Rectifier.* **S. R. Cook.** (Phys. Rev. 18. pp. 23–39, Jan., 1904. Phys. Lab. Case School of Applied Science, Cleveland, Ohio, July 22, 1903.)—After an introduction dealing mainly with the history of the subject, the author describes his experiments made with a view to obtaining an explanation of the high anodic resistance of the aluminium cell. In making the experiments the applied p.d. and the current were measured, the electrolysing current was then broken, and immediately afterwards a voltmeter was put across the cell to measure the counter-e.m.f. The error due to the interval between the last two actions not being negligibly small is discussed. Four sets of measurements at various temperatures between 1° and 58° C. with Al as anode were taken, and one with Al as kathode. The author considers that the results show conclusively that the apparent resistance of the Al anode in potassium-aluminium sulphate is not an ohmic resistance but a resistance of transition of the ions, manifesting itself in a counter-e.m.f. The film of alumina prevents the anions from reaching a conducting surface and there discharging; thus they gather round the positive plate in a layer of charged SO_4 radicles or of highly charged atoms of oxygen in the act of combining with metallic aluminium. When the Al is the kathode the kation finds access to the Al plate, and hydrogen is set free between the metal and the film, thus separating the surfaces and exposing the metal to further action. When the applied p.d. is above a critical value, the film becomes crystalline and exposes the metallic surface. The value of the critical p.d. and of the counter-e.m.f. depends on the temperature, the critical e.m.f. being 47 volts at 1° C. and 22 volts at 48°, decreasing as the temperature increases at the rate of about 1 volt per degree between 1° and 23°. The high anodic resistance depends on the temperature; on approaching 100°, at which temperature aluminium decomposes water, this high resistance greatly decreases, showing that it depends on the chemical condition for the union of Al and oxygen. L. H. W.

1145. *Influence of Temperature on the Electrical Conductivity of Potassium.* **A. Bernini.** (N. Cimento, 6. pp. 289–297, Nov. and Dec., 1903. Dal laboratorio di fisica dell' Università di Bologna.)—The probability that Matthiessen's data did not furnish correct results for the conductivity of potassium led the author to re-examine the question experimentally, as he had already done in the case of sodium. It appears that: (1) Potassium is a fairly good conductor; the specific resistance at 0° = 0·070146, at 130° = 0·1755. (2) The conductivity between the limits of temperature studied (0° to 130° C.) diminishes proportionately with the increase of temperature; (3) The coefficient of temperature is greater for the liquid than for the solid state, so that there is a sharp change in resistance at the melting point. Indeed the melting point of potassium may be determined with considerable accuracy by noting the temperature at which this sudden change occurs.

D. H. J.

1146. *Organic Solvents and Ionising Media.* I. **P. Walden.** (Zeitschr. Phys. Chem. 46. pp. 103–188, 1903. Phys. Chem. Laboratorium des Polytechnikums, Riga, Aug., 1903.)—The paper contains a long account of earlier work on the ionising properties of organic compounds, and of the methods now employed for the purification of 37 organic compounds. A table is given of the minimum conductivities observed in these compounds, and the unwarranted assumption is made that these are physical constants of the pure substances. It is also assumed that a number of these compounds are capable of self-ionisation, a conclusion which appears to be based on the supposed absolute purity of the specimens examined. The following table of dielectric constants is given:—

Substance.	Dielectric Constant 20° C.	Earlier Values
Thioacetic acid, $CH_3\cdot CO\cdot SH$	12·8	
Acetic anhydride, $(CH_3\cdot CO)_2O$	17·9	
Isobutyric anhydride, $(C_3H_7\cdot CO)_2O$	13·6	
Maleic anhydride,  $\begin{matrix} CH\cdot CO \\ \Vert \\ CH\cdot CO \end{matrix}\!\!>O$	50·0	
Citraconic anhydride,  $\begin{matrix} CH_3\cdot C\cdot CO \\ \Vert \\ H\cdot C\cdot CO \end{matrix}\!\!>O$	39·5	
Acetyl chloride, $CH_3\cdot CO\cdot Cl$	15·5	15·4 25·3
Acetyl bromide, $CH_3\cdot CO\cdot Br$............................	16·2	
Bromoacetylbromide, $Br\cdot CH_2\cdot CO\cdot Br$	12·4	
Formamide, $H\cdot CO\cdot NH_2$....................................	>84	
Acetamide (fused, 77°)	59·2	
,, (solid)	4·0	
Ethyl choloformate, $Cl\cdot CO\cdot OC_2H_5$	11·0	
Methyl cyanacetate, $CN\cdot CH_2\cdot CO\cdot OCH_3$	28·8	
Ethyl cyanacetate, $CN\cdot CH_2\cdot CO\cdot OC_2H_5$............	26·2	26·7
Ethyl benzoylacetate, $C_6H_5\cdot CO\cdot CH_2\cdot CO\cdot OC_2H_5$	9·2	11
Methyl malonate, $CH_2(CO\cdot OCH_3)_2$	10·3	
Ethyl l-malate  $\begin{matrix} CH(OH)\cdot CO_2\cdot OC_2H_5 \\ \vert \\ CH_2\cdot CO\cdot OC_2H_5 \end{matrix}$	9·3	10·0
Ethyl nitrate, $NO_2\cdot OC_2H_5$	19·4	19·6 19·7
Methyl sulphate, $SO_2(OCH_3)_2$	46·5	
Methyl borate, $B(OCH_3)_3$..	8·0	
Paraldehyde, $(CH_3\cdot CHO)_3$	11·8	
Salicylaldehyde, $HO\cdot C_6H_4\cdot CHO$	13·9	17·9 19·2

Substance.	Dialectric Constant, 20° C.	Earlier Values.
Anisaldehyde, $CH_3O\cdot C_6H_4\cdot CHO$	15·5	
Diethyl sulphide, $(CH_3)_2S$	6·2	
Methylal, $CH_2(OCH_3)_2$	2·7	
Acetone, $CH_3\cdot CO\cdot CH_3$	20·7	20·7 21·9
Mesityloxide	15·1	
Acetylacetone, $CH_3\cdot CO\cdot CH_2\cdot CO\cdot CH_3$	25·1	26·0
Acetonitrile, $CH_3\cdot CN$	35·8	36.4
Propionitrile, $C_2H_5\cdot CN$	27·2	26·5 26·8
Glycollic nitrile, $HO\cdot CH_2\cdot CN$	67·9	
Lactic nitrile, $HO\cdot CH(CH_3)\cdot CN$	37·7	
Acetyllactic nitrile, $CH_3\cdot CO\cdot O\cdot CH(CH_3)\cdot CN$	18·9	
Succinic nitrile, $(CH_2\cdot CN)_2$ [58° C.]	57·3	61·2
Benzylcyanide, $C_6H_5\cdot CH_2\cdot CN$	16·7	15·0 14·9
Methylsulphocyanide, $CH_3\cdot CNS$	35·9	
Methylmustard oil, $CH_3\cdot NCS$ [37° C.]	19·7	
Ethylsulphocyanide, $C_2H_5\cdot CNS$	26·5	
Ethylmustard oil, $C_2H_5\cdot NCS$	19·4	
Phenylmustard oil, $C_6H_5\cdot NCS$	11·0	
Nitromethane, $CH_3\cdot NO_2$	38·2	40·4 56·36
Tetranitromethane, $C(NO_2)_4$	< 2·2	
Nitrosodimethylamine, $(CH_3)_2N\cdot NO$	53·3	
Ethylaldoxime, $CH_3\cdot CH\cdot NOH$	3·4	
Mercury-diethyl, $Hg(C_2H_5)_2$	2·1	
Sulphuryl chloride, SO_2Cl_2	8·5	9·1
Chromyl chloride, $C_2O_2Cl_2$	2·6	
Arsenic trichloride, $AsCl_3$	12·8	12·4
Arsenic tribromide, $AsBr_3$ [35° C.]	9·3	
[solid]	3·4	
Sulphuric acid, H_2SO_4	>84	

T. M. L.

1147. *Influence of Occluded Hydrogen on Resistance.* **W. E. McElfresh.** (Amer. Acad., Proc. 39. No. 14. pp. 323–335, Jan., 1904.)—Knott and others have studied the effect of occluded hydrogen on the resistance of palladium, and the curve connecting those variables has been shown to be roughly a straight line *not* proceeding from the origin. The author has thoroughly investigated the matter. He measures the occluded gas by making palladium the kathode in the electrolysis of acidulated water, and he assumes that the difference between the calculated and measured hydrogen is absorbed by the palladium. The curves obtained are wavy but nearly straight, and *do* proceed from the origin. P. E. S.

1148. *Critical Review of Electrostriction.* **L. T. More.** (Elect. World and Engineer, 43. pp. 127–130, Jan. 16, 1904.)—Maxwell's theory of displacement current and electrical stresses rests on certain fundamental experiments and involves tensions along the lines of force and pressures perpendicular to them. Recent work by the author makes it doubtful if electrostriction (*i.e.*, change in length in a dielectric in an electrostatic field) has even been observed. Quincke, Cantone, Shearer, Wüllner, Wien, and the author have investigated this matter. A critical analysis of experimental results is given; the methods in some instances have been faulty, and when errors are estimated, the results are reduced apparently to *nil.* The author uses two forms of apparatus : (*a*) The adherent armature apparatus in which the dielectric, say glass, has tin foil *on* its opposite faces. When the two tin foils are oppositely charged there is an error due to mechanical compression of the glass by electrostatic attraction, also heating of the glass due to leakage. (*b*) The non-adherent armature apparatus. Here the oppositely charged metal surfaces do not touch the glass, but lard oil is inserted between in each case. The above errors are now eliminated, and the author considers that as apparatus and methods are refined the elongation diminishes and becomes a vanishing quantity. P. E. S.

1149. *Relation of Hall Effect to Current Density in Gold.* **T. C. McKay.** (Amer. Acad., Proc. 39. No. 16. pp. 353–374, Feb., 1904.)—The author states that the subject was taken up in consequence of a paper of Moretto [see Abstract No. 2032 (1900)], in which measurements of the Hall effect over a very large current range were described, and results obtained at variance with the generally bold theory of the phenomenon. The author first gives an account of the results of previous investigations, including those of Moretto; he then gives a description of the methods employed by himself, with full descriptions of the apparatus used and precautions taken. His conclusions are that Moretto's method is defective and subject to large errors. The author's work on gold appears to indicate a very small increase in the Hall effect for the weaker values of the main current, as in a decided majority of experiments the Hall effect comes out a little larger for the weaker values of the main current. The difference is perhaps within the limits of error. It may possibly be the result of the large stresses in the thin gold, due to the expansion and contraction of the paraffin and cements used to fasten the gold to the glass plate and to insulate it. Under the influence of the heating due to the strong currents, these stresses might be of a different order of strength from the stresses when a very weak current is flowing. The author proposes to continue the investigation, using other metals. E. C. R.

1150. *Polarisation and Recovery of Cadmium Cells.* **S. J. Barnett.** (Phys. Rev. 18. pp. 104–115, Feb., 1904.)—This paper consists of a plain record of tests made upon nine H-form cadmium cells set up in three separate batches by the Reichsanstalt method, and it is unaccompanied by any comment upon or conclusions drawn from the results. The cells were individually short-circuited for a few minutes through a Weston millivoltmeter of 5 ohms resistance, and current readings taken at frequent intervals. The e.m.f.'s of recovery were then obtained by connecting the cell under test in opposition with another of the cells as standard, and in series with a deadbeat galvanometer, and making simultaneous observations of time and deflection. In some of the experiments a single accumulator cell was coupled in series with the cadmium cell in order to accentuate the polarisation and (with the accumulator in the reverse direction) the recovery; and in two instances an e.m.f. of about 93 volts was put in series. Curves are given embodying all the figures obtained. The e.m.f. of the cells regained a steady value more or less rapidly according to the severity of the treatment to which they had been subjected, but ultimately they always came to within a very small fraction of 1 per cent. of their initial reading. At the start the maximum difference of e.m.f. between the cells was about 1 part in 10,000, and in later comparisons they did not differ by more than a few parts in 100,000. E. J. W.

1151. *Determination of Mutual Induction.* **A. Trowbridge.** (Phys. Rev. 18. pp. 184–186, March, 1904).—This is a simple bridge method of determining the coefficient of mutual induction of two coils, depending upon the fact that if L_1, L_2 and M are their respective coefficients of self- and mutual-induction, then their combined coefficient of self-induction when joined so as to help each other is $L_1 + L_2 + 2M$, and when so as to oppose each other is $L_1 + L_2 - 2M$. The coils are joined up to a Wheatstone bridge with a variable standard of self-induction in the third arm. Balance for steady and variable currents is obtained in the usual way, and thus the combined coefficients of self-induction of the coils in the two cases are measured. If L' and L'' are these two coefficients, then $L' = L_1 + L_2 + 2M$, and $L'' = L_1 + L_2 - 2M$, whence $M = (L' - L'')/4$. Results are given of measurements on two coils by this method and by those of Maxwell, Carey-Foster, and Glazebrook, from which it appears that the new method compares very favourably, both as regards accuracy and rapidity, with the older methods.

J. D. C.

1152. *Quadrant Electrometer.* **G. W. Walker.** (Phys. Soc., Proc. 18. pp. 453–465; Discussion, pp. 465–466, Nov., 1903.)—Instead of Maxwell's formula $F\theta = a_1(V_2 - V_1)\left\{V_3 - \frac{1}{2}(V_1 + V_2)\right\}$, the author arrives at $\left\{F + 2b_2(V_3 - V_1)(V_3 - V_2) - a_2(V_2 - V_1)^2\right\}\theta = a_1(V_2 - V_1)\left\{V_3 - \frac{1}{2}(V + V_2)\right\}$. In the actual mode of working $V_1 = O$, V_2 is very small, and V_3 is comparatively high; whence $\left\{F + 2b_2V_3^2\right\}\theta = a_1(V_2 - V_1)V_3$. This corresponds to actual results, and shows that if b_2 be positive there is a maximum sensibility depending on the potential of the needle. As the air gap is reduced the potential for maximum sensitiveness is raised and the ordinary formula is more nearly obeyed; and the sensitiveness itself may be increased, but not under all conditions.

A. D.

1153. *Direct-reading Scales for the Slide-wire Bridge.* **E. Buckingham.** (Phys. Rev. 17. pp. 382–383, Nov., 1903.)—To construct a scale of length l of this type, namely, one giving the ratio $a/(l - a)$ where a is the point of balance, construct an isosceles triangle ABC of magnitude sufficient for the accuracy required, and having the angles A and C at the base, each 30°. The line BC is subdivided equally, and the equal divisions are continued on BC produced. All the points of subdivision are joined to A, and if any line is drawn perpendicular to AC it will be subdivided by these radiating lines in the required manner. Subdivisions for any length of slide-wire are obtained by simply shifting the perpendicular to a suitable distance from A. D. K. M.

1154. *Stato-voltmeter with* 2 *to* 40,000 *Volts Range.* **V. Crémieu.** (Comptes Rendus, 138. pp. 563–565, Feb. 29, 1904.)—A horizontal bar, suspended by wires from above and below, carries at one end a metal cylinder and at the other end a coil of wire. Attraction of the cylinder, which is earthed, towards an electrified cone is balanced by the repulsion between the suspended coil and another one through both of which the same current flows. The constant of the instrument is obtained by employing the same source of current to both electrify the cone and pass a known current through the coils. Knowing the resistance of the circuit, Ohm's law gives the e.m.f. and hence the required constant. Calibration in absolute measure is effected by obtaining the torsional modulus of the suspended system from a vibration experiment. G. E. A.

1155. *New Mercury Arc Lamp.* **H. Siedentopf.** (Zeitschr. Instrumentenk. 24. pp. 22–25, Jan., 1904.)—The construction of this lamp is clear from the Fig. It consists of the lamp proper, of glass, enclosed in a water-tight brass case. The arc forms between the crater *c* and the concentric negative pole *b*, the intense light from the former being thus utilised as well as that of the arc itself. In order that the mercury forming the positive pole does not diminish by evaporation, the latter communicates with an annular space *a*, into which fall the globules formed by condensation on the walls. These walls are cooled by water, which fills the whole apparatus, and may be caused to circulate continuously through the tubulures *A* and *E*. The lower wall of the bulb *k* becomes heated by the arc, and remains clear of condensed globules, so that the light from the arc and the crater passes freely up through the lens H and is reflected as desired by the mirror S. For normal working the lamp requires 8 amperes of continuous current at 18 volts, and will run continuously with water circulation. Under these conditions the life of the lamp is several hundred hours before its working becomes impaired by the action of the alkali in the glass on the mercury. The lamp is constructed by C. Zeiss, of Jena. J. D. C.

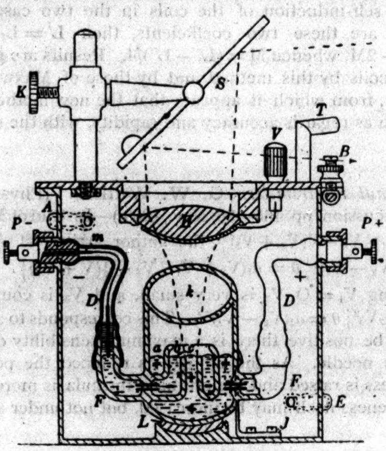


Fig. 1.

1156. *Detector of Hertzian Waves with Alternating Rotating Field.* **R. Arnò.** (Accad. Lincei, Atti, 13. pp. 272–277, March 20. Elettricita, Milan, 23. pp. 228–230, April 15. Elettricista, Rome, 3. pp. 132–134, May 1, 1904.)—The author first deals with the effects produced by electric waves on magnetisation, noticed by Rutherford, Wilson, and Marconi, with the similar effect produced by elastic deformation, observed by Sella [see Abstract No. 1134 (1904)], and with the variations produced by electric oscillations in the normal curve of magnetisation of Maurain [see Abstract No. 376 (1904)]. From these results he was led to devise an apparatus to indicate, by mechanical means, the change in hysteresis caused by the waves, a three-phase alternating rotating field producing the varying field in the magnetic material, by means of three coils placed at 120° and supplied with current at 42 cycles per sec

The magnetic body was in the form of a bifilarly suspended disc made of a mixture of iron or steel powder in paraffin, a solenoid, through which the oscillations were passed, embracing the disc. The author found that the effect of the oscillations passed through the solenoid was to produce an increase in the deflection due to normal hysteresis, readings being taken by mirror, spot and scale. With a view to increasing the field and the sensibility, an instrument was then made in which two similar discs were suspended in two equal fields rotating in opposite directions, there being thus a zero effect until oscillations are applied. [A similar differential instrument was made by L. H. Walter and J. A. Ewing, and described in a British Patent of 1902.] Discs of iron and nickel were also tried, and rings of steel wire, the latter giving greater effects, but the result was always the same—an increase of hysteresis. The frequency of the field was also varied down to 4 per sec. without any difference being observable. In an appendix, added while the above paper was about to be read, the author refers to the paper of Ewing and Walter [see Abstract No. 857 (1904)], in which the effect of oscillations in producing, under certain conditions, an increase of hysteresis is described. The author considers that, owing to his always obtaining an increase, whilst Ewing and Walter have under some conditions obtained a decrease of hysteresis, the explanation of the phenomena given by the latter is not sufficient, and he purposes carrying out a systematic investigation of the causes. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1157. *Magnetism of Basalt when heated.* **G. E. Allan.** (Phil. Mag. 7. pp. 45–61, Jan., 1904. Communicated by the Physical Society.)—The magnetic properties of magnetite have been studied. The magnetism in basalt is taken to be due to the magnetite in it; it might be thought that the properties of the rock would be similar to, but feebler, than those of the mineral. But this is not so in more than a general sense. To heat the rod of basalt it is surrounded by a tube of porcelain, on which is wound platinum wire which is insulated all round by a tube of kaolin clay, this being found less magnetic than asbestos. Outside the clay is an annular water-vessel, and outside that a magnetising coil; thus the magnetising coil can be kept cool throughout an experiment. Temperature is taken by a platinum thermometer. The magnetometric method is used. The results for susceptibility are in some cases very different according as the experiment is made on the first or second, &c., heating. The value of K tends to decrease. The result also varied according to the variety of basalt used. The values of K ($H = 46$ c.g.s.) range from 0·0013 to 0·0064, whereas that for magnetite ($H = 3·6$ c.g.s.) is 0·0166. Many curves and tables are given. P. E. S.

1158. *Experiments on Magnetism.* **T. C. Porter.** (Roy. Soc., Proc. 73. pp. 5–12, Feb. 11, 1904.)—(*a*) Crystals are allowed to form in a very powerful magnetic field, but even in the case of iron salts it is not certain that magnetic orientation exists. (*b*) Sulphur and iron are mixed in proportion to form Fe_3S_4 and then fired when in a powerful field; in this case, and also when the proportion are as in FeS, FeS_2, Fe_2S_3, the mass becomes magnetised distinctly. (*c*) Levigated iron, placed in a thick chain between the poles of a magnet and then oxidised by a flame, becomes magnetic; when this is done on charcoal the magnetism is less marked. (*d*) Levigated iron is introduced into melted paraffin wax in a field, and when the wax is solid again, it is a distinct permanent magnet. P. E. S.

1159. *Magnetisation and Resistance of Nickel Wire at High Temperatures.* **C. G. Knott.** (Roy. Soc. Edinburgh, Trans. 41. 3. pp. 39–52, March 3, 1904.)—These experiments are on the change in the electrical resistance of nickel wire magnetised longitudinally in fields up to 34 c.g.s. units at temperatures up to 342° C. The apparatus used is similar to that described in Abstract No. 1071 (1903). The results are plotted in two sets of graphs, namely, the isothermals showing the relation between magnetising force and resistance change at the various temperatures, and the isodynamics showing the relation between the resistance change and the temperatures in various fields. The resistance change diminishes in the higher fields as the temperature rises, and so rapid is the final drop above 300° C. that it may be safely regarded as non-existent at a temperature of 350° C., which is the temperature at which nickel loses its strong magnetic properties, so that the change of resistance accompanying longitudinal magnetisation is mainly a function of the magnetisation or induction in the material, and not of the magnetising force. In fields below 5 there is first an increase of the resistance change as the temperature rises, this is because the first effect of rise of temperature is to increase the permeability in lower fields, probably because of the greater ease with which the molecular groupings assume new configurations. The isodynamic curves indicate the existence of a further peculiarity which declares itself at or near the temperature of 180° C. by a kind of cusp-like peak in the graphs of the higher fields; other peculiarities of nickel at about this temperature are change of sign of the Thomson thermoelectric effect, and a sudden increase in the rate of increase of resistance with temperature about 180°–200°, which then diminishes abruptly again at about 400° C. E. C. R.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1160. *Excitation of Nerves by Condenser Discharges.* **J. Cluzet.** (Comptes Rendus, 137. pp. 670–672, Oct. 27, 1903; and 138. pp. 173–175, Jan. 18, 1904.)—Calculations of the capacity of condenser and the voltage to which it is to be charged in order to produce by its discharge, with minimum energy, the minimum effective stimulation in a nerve; also of the time during which the discharge is effective in producing stimulation; and determination of the constants a and b in Weiss's formula, that the quantity of electricity required for minimum effective stimulation is $a + bt$. Experimental verifications. Also, a is the discharge from a condenser of extremely small capacity which discharge is enough to produce some stimulation, and is between 2×10^{-10} and 4×10^{-10} coulombs; and b is V_0/R, where V_0 is the potential of a large condenser just sufficient to produce some stimulation, which potential may also be found from the strength of a continuous current just sufficient to produce stimulation by instantaneous closure of the circuit. A. D.

1161. *The Identity of the Laws of Pflüger with those of Brenner.* **V. Machado.** (Archives d'Él. Médicale, 12. pp. 83–87, Feb. 10, and pp. 209–212, March 25, 1904.)—If after the passage of a constant current through the body by means of electrodes of carbon covered with chamois leather, either of the two electrodes be applied to a third of similar nature, the former acts as an accumulator and produces a current which will deflect the needle of a galvanometer. Each electrode when applied to the skin must therefore possess two poles, a negative and a positive—one identical with that of the source of electricity to which it is connected, the other, of opposite sign, acquired by polarisation. From this it follows that each of the electrodes must retain the two gases oxygen and hydrogen produced by the electrolysis of water. According to the laws of Brenner the contraction of a muscle is sometimes produced by excitation from anodal closure and sometimes by excitation from kathodal opening. The apparent contradiction between this and Pflüger's laws is explained by the fact that in addition to the true pole, positive or negative, there is a virtual pole of contrary sign, and that excitation by anodal closure may be attributed to the closure of the virtual cathode. In the second article further experiments are described to prove that double polarisation is produced in the electrodes during galvanisation, and that when either electrode is removed, the human body will function as an accumulator generating a current opposite in direction to the primary current. H. W. P. Y.

REFERENCES.

1162. *Magnetostriction of Ferromagnetic Substances.* **R. Gans.** (Ann. d. Physik, 13. 3. pp. 634–639, Feb., 1904. Physik. Institut, Tübingen, Nov. 21, 1903.)—A criticism of the theoretical paper of A. Heydweiller [see following Abstract], in which the latter's expressions for the magnetic force and work expended are replaced by longer expressions. E. H. B.

1163. *Theory of Magnetostriction.* **A. Heydweiller.** (Ann. d. Physik, 12. 3. pp. 602–607, Sept., 1903. Physik. Institut d. Univ. Münster, June, 1903.)—A mathematical discussion of the results obtained for this phenomena by experiments on iron, nickel, and cobalt by Ewing, Bidwell, Tangl, Nagaoka, Honda, and others. E. H. B.

1164. *Transformation of Light Incident on a Moving Reflecting Surface into Electric Current.* **A. Bartoli.** (Accad. Lincei, Atti, 12. pp. 346–356, Nov. 8, 1903.)—In a former memoir (1876) the writer gave reasons, based on Crookes's discovery of the repulsion due to radiant light, for supposing that currents would be generated in a moving reflector made of conducting material. In the present paper he demonstrates experimentally the truth of his theoretical deductions. J. E.-M.

1165. *Orientation of Non-symmetrical Polarised Bodies.* **H. du Bois.** (Ann. d. Physik, 13. 2. pp. 289–324, Jan., 1904. From the Sitzungsber. d. Kgl. Akad. d. Wissensch., Amsterdam.)—The problem of the rotation about its centroid of a polarised rigid body in a uniform field of force has not hitherto been solved in the general case. Here the solution is effected by vector methods. W. S.

1166. *Mechanical Force on a Dielectric in a Varying Electromagnetic Field.* **F. Koláček.** (Phys. Zeitschr. 5. pp. 45–47, Jan. 15, 1904.)—A theoretical discussion of the recent experiments of J. B. Whitehead on this subject [see Abstract No. 241 (1903)], in which the result experimentally obtained is shown to be in harmony with Maxwell's theory. E. H. B.

1167. *Radiation from Electron describing Circular Orbit.* **O. Heaviside.** (Nature, 69. pp. 293–294, Jan. 28, 1904.)—The author shows how to obtain from a formula previously given [see Abstract No. 1080 (1903)] a complete expression for the radiation. It is pointed out that if, as is sometimes assumed, sub-atomic motions of electrons involve orbital speeds comparable with the velocity of light, the Doppler effect will play a very important part. Important simplifications are given of the analysis required to express the Dopplerised vibrations given by the formula as simply periodic vibrations. The opinion is expressed that Schuster's suggestion that Röntgen rays are due to very rapid vibrations, and that of Stokes, that they are due to collisional pulses, are both admissible, and that these rays are very probably due to the combinations of both. G. W. DE T.

1168. *Mechanical Forces Experienced by a Dielectric in an Electromagnetic Field.* Remarks on a paper by F. Koláček. **R. Gans.** (Phys. Zeitschr. 5. pp. 162–164, March 15, 1904. Physik. Institut, Tübingen, Jan. 30, 1904.)—F. Koláček has recently shown [see Abstract No. 1166 (1904)] that the negative experimental results of Whitehead on the magnetic effects of electric displacement are in agreement with the Maxwell-Hertz theory. The present author examines at length Koláček's treatment of the problem, agreeing with him in part, but disagreeing with the statement that no ballistic throw should obtain on Lorentz's theory. E. H. B.

1169. *Electrification by Compression.* **G. Martinelli.** (Accad. Lincei, Atti, 13. pp. 85–91, Jan. 17, 1904.)—Various amorphous dielectrics upon being struck become charged on the face struck and oppositely on the opposite face. In some instances stretching produces the opposite effects. The greater the striking force, the greater the consequent charges. Gradual compressions bring about similar results, and diminutions of pressure the opposite charges. A dissymmetry seems to be produced in the amorphous dielectric by the pressure. Gum lac seems to be not truly amorphous, but to have a polarity of structure of its own. [See also Abstract No. 347 (1904).] A. D.

1170. *New Theory of Influence Machines.* **V. Schaffers.** (Comptes Rendus, 138. pp. 354–355, Feb. 8, 1904.)—The author explains the working of influence machines from the fact that the capacity per unit of surface of the plates is a maximum in front of each armature, from there it decreases rapidly, and consequently the potential rises. It is in these regions of maximum potential that the arrangements for recharging the opposite armature are placed, and that is why this armature increases its charge. The reason that the charges on the armatures do not increase indefinitely is that, as the potential rises, the region of inversion of charge advances, and this advance makes the region of maximum potential move back, so that the arrangements for recharging the armatures finally are at a potential which is no longer higher than that of their armatures, and the charge becomes stationary. E. C. R.

1171. *Electromagnetic Waves and Lippmann's Mercury Jet.* **A. Trowbridge** and **L. Amaduzzi.** (N. Cimento, 5. pp. 322–325, May, 1903.)—The arrangement consists of a tube of mercury, ending below in a capillary bore, liquid electrolyte, and mercury under the electrolyte, all inserted in a circuit; if the pressure of mercury in the tube be just sufficient, and no more, to keep up a downward flow of mercury, electromagnetic waves started by an instantaneous current in the same sense as that of the jet-electrolyte-mercury couple will arrest the flow; if the instantaneous current be in the opposite direction, the jet will experience an impulsion. If there be no jet and if there has been oxidation, at a given moment this oxide will be pierced by a spark. A. D.

1172. *Atmospheric Potential Gradient.* **H. Ebert.** (Phys. Zeitschr. 5. pp. 135–140, March 1, 1904. Physik. Institut der techn. Hochschule, München, Jan., 1904.)—A treatment of the causes of the potential gradient in the atmosphere and the negative charge on the earth from the standpoint of modern theory as to electrons and ionisation. E. H. B.

1173. *Electric Field Round a Röntgen-ray Tube.* **P. Mulholland.** (Röntgen Ray, Archives, 8. pp. 8–15; Discussion, p. 15, June, 1903.)—During the intervals between discharges there is an ordinary static field, which can be detected by a small electroscope with leaves of aluminium foil within a metallic case, which can be earthed; and this field can be cut off by an earthed metal plate. During the period of discharge there are oscillatory disturbances, which can be detected by a vacuum tube; and there are also Hertzian waves, in two groups, one from 12 to 18 in. in length and the other from one 1 in. to 2 or 3 in. Experiments analogous to the use of a tube with singing flames, reinforcing some Hertzian waves and harmonics of these, even to such an extent as to impose high-frequency oscillations upon the whole *primary* system of the coil. There are some signs of polarisation in the reinforced waves. Suggestions are made as to methods of eliminating any of the various component disturbances as affecting a patient in the field of a focus tube, and producing, as regards him, only the particular type of disturbance required for medical purposes. A. D

1174. *Further Experiments with the Coherer.* **P. E. Robinson.** (Phys. Rev. 17. pp. 286–291, Oct., 1903.)—The author employs a coherer of twice the capacity of that used in his former experiments [see Abstract No. 1135 (1904)]. The action of waves and of a direct-current was investigated, and especially the impulse value of the resistance (to which the coherer resistance drops on applying a p.d. greater than the critical value), and the relation traced between these values and the applied p.d. For each p.d. there was found a definite final resistance, and fatigue was very manifest, even with direct-current. The results are irregular, which the author attributes to change of sensitiveness and fatigue. The author, finally, still holds to his theory that the fatigue may be caused by the spark [in the present case the transmitter was only 5 m. distant, so that a spark was not impossible], in spite of Huth's results. [See Abstract No. 1136 (1904).] L. H. W.

1175. *The Mercury Arc.* **de Valbreuze.** (Soc. Int. Élect., Bull. 3. pp. 518–529, Dec., 1903.)—The author deals chiefly with the effects observed at different vacua; the appearance of stars and striæ has been described in a former paper [see Abstract No. 604 (1904)]. The pressures employed varied from 4·2 mm. of mercury down to 0·05 mm. (and lower), at which latter pressure the lamp functioned normally, the terminal p.d. for the same series varying from 450 down to 15 volts. When the pressure was reduced below 0·005 mm. great difficulty was experienced in starting the discharge, requiring for pressures of 2·5, 1·5, 0·065, 0·01, and 0·006 mm., terminal p.d.'s of 350, 1,500, 800–1,000, 5,000–6,000, and 8,000 volts respectively. L. H. W.

1176. *A Singing Vacuum Tube.* **W. J. Hammer.** (Elect. World and Engineer, 43. pp. 47–48, Jan. 2, 1904.)—The anode of a Röntgen-ray tube was accidentally perforated, the vacuum being thereby lowered as the occluded gases in the platinum were driven out. If the anode is heated red-hot, and the tube then laid down on the closed cardboard box, a low musical note, A, is heard, and on placing the hand on the tube it is felt to be vibrating. The action is maintained for a long time—5 to 17 min. In explanation the author suggests: (*a*) a Trevelyan rocker action; (*b*) the tube is a resonator of some etheric vibration, the tube only being sensitive for some time after it has been excited by the ordinary current in it. P. E. S.

1177. *Back-electromotive Force of the Electric Arc.* **W. Mitkiewicz.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 1b. pp. 13–20, 1904.)—After extinction the author has found an e.m.f. (greater than 1·5 to 2 volts) between the positive and negative electrodes of the arc, the views of Duddell with respect to the nature of the back-e.m.f. of the arc thus being borne out. A. G.

1178. *Ionisation in Flames.* **F. L. Tufts.** (Phys. Zeitschr. 5. pp. 76–81, Feb. 1, 1904. From the English.)—The relation between current, distance between the electrodes, and strength of field depends on the relative resistances of the layers near the electrodes, and those further removed. By covering the platinum electrodes with oxides of Ca, Ba, or Mg, the number of ions in their neighbourhood is greatly increased and the resistance there is diminished. Solutions are now sprayed into distant parts of the flame, and the effect of concentration, length of path, &c., investigated. It is concluded that there is volume ionisation when salts are introduced into flames. R. S. W.

1179. *Currents Carried by Kathode and Canal Rays.* **F. Leininger.** (Phil. Mag. 7. pp. 180–199, Feb., 1904.)—The anode and kathode are of wire gauze; the kathode and canal rays coming through are caught on a collecting electrode behind them. Both main current and currents carried by the rays can thus be measured. It is found that the proportion carried by canal and kathode rays increases rapidly as the pressure decreases, until finally it appears to account for the total current. The absorption of canal rays by gases is greater than that of kathode rays. R. S. W.

1180. *Divergence of Electroscope Leaves Caused by Light.* **S. Guggenheimer** and **A. Korn.** (Phys. Zeitschr. 5. pp. 95–96, Feb. 15, 1904. Phys. Inst. der Univ. München.)—If the leaves of an electroscope, placed in a vacuum, are illuminated strongly, they diverge and are shown to be charged with positive electricity. If they are first charged, positively or negatively, the divergence is increased. It is uncertain whether this is an electrical or a radiometer effect. [See also next Abstract.] R. S. W.

1181. *Divergence of Electroscope Leaves Caused by Light.* **F. Paschen.** (Phys. Zeitschr. 5. pp. 161–162, March 15, 1904.)—Reasons are given for believing this to be entirely a radiometer effect. Thus, if the electroscope be made of one thick piece of metal to which a thin leaf is attached, and if it be illuminated on the thin leaf side, the divergence is nearly instantaneous. If illuminated from the thick metal side it grows but slowly. The author was unable to establish the existence of a positive charge, as did Guggenheimer and Korn. [See also preceding Abstract.] R. S. W.

1182. *Blowing Out of the Electric Spark.* **J. Lemoine** and **L. Chapeau.** (Comptes Rendus, 138. pp. 623–625, March 7, 1904.)—The spark is photographed by the help of a rotating mirror; each photograph is then seen to consist of about 36 separate sparks more or less unevenly distributed. When the apparatus has been working for some hours, a photograph taken appears altogether different. It now consists of a larger number of separate sparks more uniformly arranged. This is due to the surface of the sparking spheres becoming uneven, the potential required to produce the spark is then less than it was originally. R. S. W.

1183. *Regulation of Ships' Compasses.* **H. Meldau.** (Phys. Zeitschr. 5. pp. 42–45, Jan. 15, 1904.)—Following his papers on like subjects [see Abstracts Nos. 842 (1903) and 160 (1904)] the author gives the results of experiments on various ships. The vertical force (perpendicular to the deck) is found to vary very greatly according as iron or wooden walls are used in the compass-house. It is reduced to a very small quantity in certain cases where only wood is used. P. E. S.

1184. *Protection of Machines Supplying High-frequency Generators.* **d'Arsonval** and **Gaiffe.** (Comptes Rendus, 138. pp. 325–326, Feb. 8, 1904.)—The authors describe an arrangement for preventing the high-frequency oscillations from finding their way to the low-tension transformer or other source of supply to the high-frequency generator. This consists of a pair of choke coils, wound on insulated thin copper tube, inserted between the transformer terminals and the spark-gap, two condensers being connected to the transformer terminals in shunt to the gap. This arrangement is stated to remove all traces of discharges from the connected apparatus. L. H. W.

1185. *Electrical Conductivity of Liquid Films.* **L. J. Briggs** and **J. W. McLane.** (Phys. Rev. 18. p. 123, Feb., 1904. Abstract of paper read before the meeting of the American Physical Society, Dec. 30, 1903.)—The authors have made some preliminary measurements of the specific electrical conductivity of films of Plateau's solution (*liquide glycérique*) by a method in which the thickness of the film is calculated from the surface area and weight of the film. The measurements were made on a cylindrical film supported horizontally on two parallel platinum rings fixed to a frame which could be attached to the balance or to the bridge as desired. The results show that the specific electrical conductivity of a film approximately 1μ in thickness is less than one-third of that of the solution in mass. The method of experiment involves the assumption that the density of the film is the same as that of the liquid in mass. W. C. H.

1186. *Selenium Resistance Cells.* **J. W. Giltay.** (Phys. Zeitschr. 4. pp. 287–289, Feb. 15, 1903.)—The method of demonstration consists in illuminating the selenium cell intermittently by an arc lamp or other source, the light from which passes through a rotating perforated disc. A telephone in the circuit of the cell and battery emits a tone which is the same as that of the disc, at any instant. Or the light can be made intermittent by the use of acetylene lamps provided with a vibrating diaphragm. The author prefers direct illumination, without lenses. In order to avoid injury to the selenium cells from the inductive current when breaking or completing the circuit, the cells are at such times short-circuited or shunted. R. A.

1187. *Measurement of Magnetic Force.* **G. F. C. Searle.** (Electrician, 51. pp. 319–320, June 12, 1903.)—In order to measure the magnetic force due to the magnetising current in ballistic tests of iron rings the author uses a Weston millivoltmeter connected in parallel with a suitable shunt. A resistance coil placed in series with the instrument reduces the sensitiveness, the resistance of this coil being so adjusted that its voltmeter reading is a simple multiple of the magnetic force due to the current. E. S. A. R.

1188. *Static Electricity in the Treatment of Morphinism.* (Revue Int. d'Électrothérapie, 13. p. 213, Dec. 1903, and Jan., 1904.)—A. J. P. Ressey (of Cleveland) has found static electricity of value in the treatment of morphinism. It alleviates the adverse symptoms which arise in the more or less rapid reduction of the dose of the drug, more especially the gastric troubles and the neuralgic and other nervous phenomena. H. W. P. Y.

1189. *Therapeutic Experiments with Fluorescent Substances.* **H. v. Tappeiner** and **Jesionek.** (Revue Int. d'Électrothérapie, 13. p. 212, Dec., 1903, and Jan., 1904.)—Various skin diseases were treated by frequent bathing with a 5 per cent. solution of eosin, and exposure to the sun's rays or in dull weather to the light from an electric lamp. In three cases of cancer of the skin of the face the ulcerated surfaces became covered with healthy granulations. Superficial patches of lupus were very favourably influenced by the treatment. H. W. P. Y.

1190. *Uses of the Chord Galvanometer.* **W. Einthoven.** (Ann. d. Physik, 12. 5. pp. 1059–1071, Nov., 1903; 14. 1. pp. 182–192, May, 1904. From the Physiological Laboratory of the Leiden University. Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 876–884, March, 1904.)—The improvements in sensitiveness of the instrument, as compared with the earlier form described in Abstract No. 1451 (1903) are dealt with, and various tests with radio-active salts and with flames are described to show the sensitiveness and reliability of the instrument. It is shown that quantities of 5×10^{-12} coulombs can be measured. In many cases the instrument can be used instead of an electrometer. It can also analyse sound waves.
H. H. F. H.

1191. *Radium from the Medical Point of View.* **J. Bergonié.** (Archives d'Él. Médicale, 12. pp. 123–132, Feb. 25; and pp. 175–187, March 10, 1904.)—The author deals with the properties of the various radiations from radium as far as their use for medical purposes is concerned, and gives a scale of their penetrating powers as compared with the radiation from a Crookes' tube, such scale being on similar lines to that proposed by Benoist for Röntgen rays. [See Abstract No. 679 (1902).]
L. H. W.

1192. *Electrical Resistance of the Human Body.* **S. Leduc.** (Archives d'Él. Médicale, 12. pp. 43–50, Jan., 1904.)—When there is good contact between the electrodes and the skin, the electrical resistance depends, firstly, on the size of the electrodes; secondly, on the part of the body to which they are applied; thirdly, on the nature of the ions employed and the extent to which the skin is saturated by them; fourthly, on the rapidity of the introduction of the ions, that is, on the voltage at which the resistance is measured; and lastly, on the individual peculiarities of the subject, both physiological and pathological. [See also Abstract No. 382 (1904).]
H. W. P. Y.

1193. *Radiotherapy in the Diagnosis and Treatment of Certain Fibromata.* **F. de Courmelle.** (Comptes Rendus, 138. pp. 114–115, Jan. 11, 1904.)—Two cases of abdominal tumour in patients who had declined operation were treated by radiotherapy, resulting in great improvement in general health and reduction in size of the tumours. The author suggests that since the Röntgen rays may be regarded as a quasi-specific for cancer, they would be of value not only in the treatment of abdominal tumours of doubtful nature, but also in diagnosis. H. W. P. Y.

1194. *Exact Measurements in Radio-therapeutics.* (Röntgen Ray, Archives, 8. pp. 151–152, Feb., 1904.)—A "chromo-radiometer" has been invented by Holzknecht, which consists of two parts—a measurer and a comparative scale. Certain salts, colourable by Röntgen rays, embedded in a transparent substance, are used as the measurer, and the scale is a series of twelve samples of the salt, of graduated colours, enclosed in a light-tight box. In practice the measurer is placed on the skin, and when the colour equals a selected one of the scale the exposure is correct.
H. W. P. Y.

1195. *Röntgen Rays in the Diagnosis of Pulmonary Tuberculosis.* **A. S. Green.** (Röntgen Ray, Archives, 8. pp. 144–149, Feb., 1904.)—The author quotes cases to prove the superiority of Röntgen-ray examination over ordinary methods in the diagnosis of incipient pulmonary tuberculosis and in the observation of the progress of the disease. In examining the chest with the screen, the movement of the diaphragm, both in quiet and in forced respiration and the position of the heart, should be noted, and the differential transradiancy of corresponding areas of the two sides should be carefully compared. Skiagrams should, if possible, be taken while the ribs are motionless, that is while the patient holds his breath. H. W. P. Y.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1196. *Variation of Angles Observed in Crystals, especially of Potassium-Alum and Ammonium-Alum.* **H. A. Miers.** (Roy. Soc., Phil. Trans. 202. pp. 459–523, Dec. 15, 1903. Roy. Soc., Proc. 71. pp. 439–441, April 30, 1903.)—The changes of angle during the growth of a crystal were traced by measuring it at intervals without moving it from the solution in which it was growing. This was accomplished by means of a new telescope-goniometer, in which the crystal, held by a platinum clip which it enveloped as it grew, was observed through one side of a rectangular glass trough, and the changes in the inclination of each face were followed by watching the displacements of the image of a collimator slit viewed by reflection in it. Examined in this way, an octahedron of alum was found to yield not one but three images from each face; and closer inspection showed that the crystal was not really an octahedron, but had the form of a very flat trialsis-octahedron, though usually of the three vicinal faces one was large and the other two so small that they only gave very faint reflections. When a growing crystal of alum is watched for several hours or days, it is found that the three images yielded by an apparent octahedron face continually change their position; one set fades away and is replaced by another set, which are generally more widely separated than those which they succeed. The images do not move continuously, but *per saltum*, indicating that the reflecting planes are vicinal faces which probably possess rational indices, and must therefore be inclined at certain definite angles to the octahedron face; but the indices are very high numbers. Observations upon sodium chlorate, zinc sulphate, magnesium sulphate, and other substances, show that other crystals exhibit the same behaviour. The faces of a crystal are in general not faces with simple indices, but vicinal planes slightly inclined to them, and they change their inclinations during the growth of the crystal. In order to ascertain the composition of the liquid in ultimate contact with the growing crystal, attempts were made to determine its refractive index by means of total reflection within the crystal. Considerable difficulty was experienced in making this measurement, but ultimately good readings were obtained, which gave the value 1·34428 as the refractive index in sodium light, at 19° C., of the liquid in contact with a growing crystal of alum. The refractive indices of a series of solutions of known strength, ranging from dilute to supersaturated, were measured, and the above index was found to correspond to a liquid containing about 10·80 grammes of alum in 100 grammes of solution. A saturated solution at 19° C. was found to have the refractive index 1·34250, and to contain about 9·01 grammes of alum in 100 grammes of solution. Similar measurements were made with sodium chlorate and sodium nitrate. In each case the liquid in contact with the growing crystal was slightly supersaturated, but it was not found to exhibit double refraction even in the case of sodium nitrate, which crystallises in a bi-refringent system. T. M. L.

1197. *Apertures of Coronas in Relation to Nuclei.* **C. Barus.** (Amer. Journ. Sci. 15. pp. 335–341, May, 1903.)—Various measurements on coronas. From the results the use of the apertures of coronas seems preferable to that of the colours of the annuli for estimating the number of particles corresponding to a given degree of supersaturation at a given temperature. A given aperture is, however, only of value when qualified by the type of corona to which the aperture belongs. The author calculates there must be at least a million nuclei per c.cm. of the air immediately in contact with a surface of phosphorus. From electrometer observations the number obtained was $2 + 10^6$. Thus the two distinct methods lead to results of the same order. J. J. S.

1198. *Theory of Coloured Indicators.* **P. Vaillant.** (Comptes Rendus, 136. pp. 1192–1195, May 18, 1903.)—The author does not agree with the view of Ostwald and Nernst, that it is owing to the different colours of the non-dissociated indicator-acid RH or base ROH and the ions R that a compound acts as an indicator, since, according to the law of mass action, the colour of the ion of the non-decomposed salt must play a large part. If, for example, a potassium hydroxide solution be mixed with an acid indicator, RH, RK is formed, and this, being a salt of a weak acid and in presence of excess of potassium hydroxide, can only yield a few R ions; hence the colour of the solution is that of RK. On titration with acid this becomes converted into the slightly dissociated HR, so that here also the influence of the colour of the R ions is negligible. Investigations by means of Gouy's spectro-photometer show that the potassium derivative of *p*-nitrophenol has the same colour as its anion, whilst *p*-nitrophenol itself is colourless. From the absorption coefficients of the potassium compound of *p*-nitrophenol by itself, and when mixed with excess of potassium hydroxide, the degree of hydrolytic dissociation of the former can be calculated. With increasing concentration the dissociation at first quickly diminishes, then remains approximately constant over a certain interval, and again falls at higher concentration. This behaviour is in accord with the law of mass action. [See also Abstract No. 441 (1904.)]

T. H. P.

1199. *Preparation of Argon from Liquid Air.* **Rayleigh.** (Phil. Mag. 5. pp. 677–680, June, 1903.)—Owing to the fact that the boiling-point of argon is lower than that of oxygen and higher than that of nitrogen, the samples of gas given off during the evaporation of liquid air become richer in argon and oxygen as the process goes on. The author proposes to utilise this to expedite the preparation of argon. The evaporation may be allowed to go on till the gas coming off contains about 60 per cent. of oxygen (and then also 2 per cent. of argon), a sufficient proportion to oxidise all the nitrogen under the action of the electric discharge of a Ruhmkorff coil. If oxygen is mixed with atmospheric air to produce the same proportions, the argon only amounts to 0·4 per cent. As the oxygen is easily got rid of, the evaporation may be carried to greater lengths till, for example, the proportion of oxygen is 90 per cent., and that of argon to argon plus nitrogen 20 per cent. The oxygen is then first absorbed, and finally the nitrogen, by heating calcium, or lime-magnesium mixture. A short table is given of analyses of samples of gas obtained at various stages of evaporation [see Abstract No. 405 (1904).]

J. D. C.

1200. *Purification of Hydrogen by Cold.* **C. Renard.** (Comptes Rendus, 136. pp. 1317–1318, June 2, 1903.)—It is known from the experiments of d'Arsonval that hydrogen can easily be separated from other gases with which it is usually mixed, even in the case of coal gas, by cooling the mixture with liquid air. In conjunction with G. Claude an attempt has been made to purify hydrogen required for military balloons. A preliminary test was made by using a glass cylinder 120 mm. diam. partly filled with gasoline through which very impure hydrogen (produced from commercial acid and zinc) bubbled. Within the cylinder was placed a vertical eprouvette containing liquid air, by the aid of which the temperature of the gasoline bath could be reduced to about —130° C. Each sample of gas purified was of about 4 litres, and the speed of production varied from 1 to 2 litres per min. An analysis of the gas showed that when the temperature was lowered to —130° the gas was freed in a very certain manner from every trace of arsenic. A scheme has been proposed to purify hydrogen at the rate of 25 cub. m. per hour, and has been submitted to the military Service de l'Aérostation. W. W. H. G.

1201. *Liquefaction of Air.* **G. Claude.** (Comptes Rendus, 136. pp. 1659–1661, June 29, 1903.)—The phenomena relating to the evaporation of liquid air have been studied by Linde and Branly, but the condensation of air has relatively been little investigated. According to Linde, the two gases of air condense simultaneously, whereas Pictet holds that nitrogen is the first to liquefy. In order to settle this point, trials have been made with an apparatus similar to that described in Abstract No. 404 (1904). The result is in accordance with the predication that the condensation of the mixture of which air consists is in the inverse order to that in which the constituents of liquid air vapourise, and therefore the oxygen will be the first to appear in liquid form. W. W. H. G.

1202. *Molecular Weight Determinations from Measurements of Freezing-points and Boiling-points.* **E. Beckmann.** (Zeitschr. Phys. Chem. 46. pp. 853–866, 1903. Laboratorium für angewandte Chemie, Leipzig.)—I. Methylene iodide exists in two modifications melting at 4° and 4·47° (pressure 734 mm.), the molecular depression for the two forms being found from measurements of solutions of camphor and of benzoylmenthol to be 137 for the former and 144 for the latter modification. Determinations of the molecular weight of sulphur, phosphorus, and iodine in methylene iodide solution, as determined from the freezing-point of the two modifications, gave results agreeing with those found when carbon disulphide was used as solvent. II. Ferric chloride and aluminium chloride give values for the molecular elevation of the boiling-point in ethereal solution which agree closely with the formulæ $FeCl_3$ and $AlCl_3$, but aluminium dissolved in boiling bromine gives values corresponding with the formula Al_2Br_6 for the bromide in this solution. Tetrabromomethane, CBr_4, and tin (in the form of stannic bromide $SnBr_4$) give normal values for the molecular weight in boiling bromine, but *m*-bromobenzoic acid appears to be partially polymerised, as the values found for the molecular weight are about 50 per cent. greater than the theoretical value; arsenic and antimony also give values which indicate that the bromides ($SbBr_3$ and $AsBr_3$) contain only a single atom of the metalloid and are not polymerised. T. M. L.

1203. *Viscosity of Mixtures of Water and Phenol.* **O. Scarpa.** (N. Cimento, 6. pp. 277–288, Nov. and Dec., 1903. R. Istituto di Studi Superiori, Florence, Nov., 1903.)—The author gives, in curves and tables, the results of measurements of the viscosity of mixtures of phenol and water in various proportions at different temperatures. The viscosity isotherms all exhibit two singular points corresponding approximately with mixtures containing respectively 58 and 15 parts of phenol per 100 of mixture. This phenomenon must be attributed to the existence of a molecular complex or aggregate, the action of which on the viscosity is especially noticeable for concentrations lying between the two singular points, and is manifested most markedly at and about the temperature of critical solubility, while it diminishes as the temperature rises, probably owing to gradual dissociation of the complex. The composition of the complex is most likely $C_6H_5OH + 5H_2O$. The viscosity curves also indicate that this compound only exists in solutions of phenol saturated at temperatures near that of critical solubility. [See also Abstract No. 1314 (1903).] T. H. P.

1204. *Synthetical Preparation of Krugite.* **A. Geiger.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 53. pp. 1123–1124, Dec. 17, 1903.)—Of the two triple sulphates occurring at Stassfurt, namely, polyhalite, $Ca_2K_2Mg\ (SO_4)_4$, $2H_2O$, and krugite, $Ca_4K_2Mg\ (SO_4)_6$, $2H_2O$, the former was prepared by Basch in 1900. The latter was discovered by Nidda in 1880 in two places in the Stassfurt beds at a depth of about 300 m., the two deposits containing about 35,000 and 2,500 kg. respectively. Pfeffer has suggested that it has been formed from polyhalite and gypsum, and attempts were therefore made to prepare it by bringing together 1 mol. polyhalite and 2 mols. gypsum in contact with solutions with which both are stable. These experiments were unsuccessful, and 20 gm. of an active form of gypsum were therefore brought into contact with 283 gm. of the solution from which Basch obtained polyhalite, but omitting magnesium sulphate, the composition of the solution used being 1,000 H_2O, $41MgCl_2$, $8K_2SO_4$. After keeping at 100° during six days, and again at 83° during eight days, the gypsum was completely converted into krugite of normal composition. T. M. L.

1205. *Explosive Antimony.* I. **E. Cohen** and **W. E. Ringer.** (Zeitschr. Phys. Chem. 47. pp. 1–28, Jan., 1904.)—The discovery was made by Gore in 1855 that antimony electro-deposited at a high current density from concentrated acid solutions of the chloride, bromide, and iodide possesses explosive properties, and he found further that the product contained 6·3 per cent. of $SbCl_3$, or 20 per cent. of $SbBr_3$, or 22·2 per cent. of SbI_3, which was for the most part vaporised by the explosion. The present paper contains a description of the materials and apparatus used in preparing explosive antimony and of the analytical methods employed. The antimony was estimated electrolytically, and it is of interest to note that the chief difficulty, arising from the non-adherence of the metallic deposit to the platinum dish, was discovered to be due to traces of iron. The explosive antimony was deposited on a platinum wire, and after exploding in a hard-glass tube was heated in an atmosphere of carbon dioxide and found to give off a considerable amount of antimony chloride as well as traces of hydrogen chloride; during the heating of the exploded antimony it was observed to swell and move much after the fashion of the so-called Pharaoh's serpents. Quantitative experiments showed the presence of 0·03 to 0·06 per cent. HCl and about 0·3 per cent. of moisture. When cooled with ice and salt, small rods of explosive antimony can be powered without undergoing change, and larger rods can be similarly treated at lower temperatures. Advantage was taken of this fact in order to determine whether the chloride was mechanically enclosed in the explosive metal. The method adopted was to cover the metal with a mixture of alcohol and ether (which, unlike water, does not dissolve any trace of metallic antimony), and after cooling to $-80°$ C. with carbon dioxide snow, to grind it up to a fine powder; the resulting liquid was filtered and found to be quite free from antimony, showing that the chloride was not mechanically included in the metal. A similar experiment was made with exploded antimony; the explosion was brought about under ether, so as to prevent heating, and the product was powdered and digested at 4° during several hours, but retained the whole of the antimony chloride, and the solution was quite free from antimony. Experiments were made to determine the influence of the experimental conditions on the proportion of included antimony chloride and on the character of the metallic deposit. The current-density has little influence, an eight-fold increase only lowering the percentage of chloride from 5·65 to 5·00 per cent.; this is in accord with the observations of Pfeifer. The following table shows the influence of the concentration of the chloride solution at 15° C., current 0·2 to 0·3 ampere :—

$SbCl_3$ per cent. in Solution.	$SbCl_3$ per cent. in Metal.	Character of Metal.
3·08	1·64	Not explosive.
5·15	1·70	„
8·06	1·82	„
10·43	4·53	Explosive.
11·92	4·82	„
16·63	5·15	„
18·07	5·35	„
18·80	5·65	„
33·05	6·75	„
44·90	7·00	„
55·35	8·24	„
70·14	5·94	„
85·70	10·51	„

It will be noted that there is an abrupt rise in the proportion of antimony in the metal when the proportion in the solution passes 10 per cent., and that this exactly corresponds to the transition from the non-explosive to the explosive form.

The influence of temperature is shown by the following table :—

Temp.	$SbCl_3$ in Solution.	$SbCl_3$ in Metal.	Character of Metal.
0	21·24	5·22	Metallic, lustrous, explosive.
0	15·6	3·81	„ „ „
30·0	21·24	5·54	„ „ „
30·0	15·6	1·76	„ not „ not „
50·5	21·24	2·64	„ „ „ „ „
50·3	15·6	1·96	„ „ „ „ „
96·0	21·24	0·76	„ „ „ „ „
93·5	15·6	0·17	Powdery, „ „

Increasing the temperature therefore decreases the amount of chloride in the metal and its tendency to explode, but this can be partially counterbalanced by increasing the concentration of the solution. T. M. L.

1206. *Toxic Action of Acids and Salts on Seedlings.* **F. K. Cameron** and **J. F. Breazeale.** (Journ. Phys. Chem. 8. pp. 1-13, Jan., 1904.)—The authors have carefully determined for certain plant seedlings the death or "toxic" limit of concentration, in aqueous solution, of a number of acids and the corresponding potassium and calcium salts. The criterion employed was the obvious death and flaccid condition of the tip of the radicle for the first 15 mm. from the apex. The absolute length of the radicle from plumule to apex, if the seedlings did not vary too much in age, appeared to have no effect upon the result. Indian corn seedlings survive in much stronger solutions of nitric than of sulphuric and hydrochloric acids, and acetic and succinic acids are borne in stronger solutions than oxalic and malic acids, and all four give higher figures than nitric acid. For clover seedlings, however, the figures are the same for all acids, namely, N/20,000. In saturated solutions of the slightly soluble sulphate, oxalate, succinate, malate or carbonate of calcium, the seedlings all thrive vigorously. Seedlings of wheat or clover are invariably killed by distilled water saturated with Co_2, but corn seedlings usually survive. The result obtained with clover seedlings would indicate that the toxic action was due to the hydrogen ion alone; for it must be assumed that with a dilution N/20,000 practically ample dissociation existed for each of the acids; but with corn seedlings it cannot be regarded as due to the effect of the hydrogen ion alone. Clover seedlings are able to stand a much stronger solution of potassium chloride than of potassium nitrate or sulphate, while wheat seedlings require a more concentrated solution of the sulphate and chloride than of the nitrate and oxalate to kill them. These results cannot be explained as produced mainly by the kations, and modified by the anions, since for wheat seedlings nitric acid is less toxic than hydrochloric or sulphuric acid, but potassium nitrate is more toxic than the potassium salts of the latter acids. The presence of calcium salts ameliorates the toxic effect of acids upon corn seedlings, but the presence of potassium salts apparently increases the toxic effect of acids upon seedlings of clover. Such studies as these may be of use in throwing light upon physiological questions such as the art of fertilising and liming of soils, but are of little value as a quantitative investigation of dissociation phenomena. The physiological peculiarities and idiosyncrasies of the organisms must be taken into account.

H. W. P. Y.

1207. *Production in the Cold of Sulphides of Phosphorus.* **R. Boulouch.** (Comptes Rendus, 138. pp. 363–365; Feb. 8, 1904.)—The direct interaction of sulphur and phosphorus, when heated together, yields as the chief product the compound P_4S_3. When this is dissolved in carbon disulphide, mixed with sulphur and a little iodine, the violet colour soon disappears, and at the end of two or three days, after exposing the flask to sunlight, crystals separate, which can be freed from adhering solvent only by fusion, and have the composition P_4S_5. When sulphur and phosphorus are dissolved in carbon disulphide little or no interaction takes place even on exposure to sunlight, but on adding a few particles of iodine, combination takes place, and at the end of a few days, if the sulphur is in excess and the flask is exposed to light, crystals separate which appear to be identical with Seiler and Ramme's P_3S_6. When the action is complete the colour of the iodine reappears.

T. M. L.

1208. *Action of Heat and of Light on Mixtures of Phosphorus Sesquisulphide and Sulphur Dissolved in Carbon Disulphide.* **E. Dervin.** (Comptes Rendus, 138. pp. 365–366, Feb. 8, 1904.)—The P_8S_{11} of the author is not identical with Boulouch's P_4S_5, although the two compounds resemble one another. [See preceding Abstract.] It is pointed out that (1) P_8S_{11} heated to 210° with CS_2 breaks up into P_2S_4, which crystallises, and P_4S_3 which remains in solution. (2) P_8S_{11} heated to 210° with P_4S_3 and CS_2 does not break up, and recrystallises unchanged. (3) P_2S_4 and P_4S_3 heated to 210° with CS_2

reproduces P_8S_{11}. The separation of P_3S_4 and P_8S_{11}, which are both produced by the action of heat and of light on solutions of sulphur and phosphorus sesquisulphide in carbon disulphide, can be largely effected mechanically. To complete the purification the crystals are transferred to a tube which is nearly filled with carbon disulphide and sealed; the lower part of the tube is heated to 100°, and the upper part is cooled with water, and at the end of a day the upper part of the tube contains a large crop of pure crystals.

T. M. L.

1209. *Action of Radium on Metals.* **N. Orloff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 2b. pp. 41–45, 1904.)—An ebonite capsule containing 0·03 gm. of radium bromide was covered in April, 1903, with an aluminium plate 0·01 mm. thick, instead of the mica generally used. In the course of July the author, on opening the capsule, noted on the surface of the aluminium turned towards the radium some protuberances of the same aspect as the surrounding surface of the aluminium, and resembling small drops of melted metal. These protuberances proved to be radio-active, producing a photographic image on acting for some minutes through black paper, and even after six months they were found to emit invisible radiation without appreciable weakening. The author thinks that a stable alloy is formed by the accumulation of material particles given off from the atomic systems of radium, around small aluminium nuclei. A. G.

1210. *Separation of Radium.* **W. Marckwald.** (Chem. News, 89. pp. 97–98, Feb. 26, 1904. From Berichte der Deutsch. Chem. Gesell.)—A method of separating radium chloride from barium chloride is described. If a concentrated solution of radium barium chloride is shaken up with a fifth of its weight of sodium amalgam, a radium and barium amalgam is formed, and the proportion of radium to barium in the amalgam is very much higher than in the solution. By repeating the process many times the radium can be accumulated. If in the freshly-prepared solution of the radium barium chloride obtained directly from the Joachimsthal pitchblende certain metals are immersed they become very strongly radio-active. The order of the metals with regard to the intensity of this induced radio-activity is magnesium, zinc, tin, copper, silver, bismuth, palladium. J. J. S.

1211. *Dibenzal- and Benzalmethyl-glucosides.* **W. A. van Ekenstein.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 452–453, Feb. 25, 1904. Translated from Versl. van de gewone vergadering der Wis- en Natuurkundige Afdeeling, Jan. 30, 1904. Lab. of the Fin. Dep., Nov., 1903.)—The author has prepared the above substances by condensing benzaldehyde and the sugar by means of phosphorus pentoxide. Their properties are: dibenzalarabinose melts at 154°, has $[\alpha]_D = +27°$ (in methyl alcohol). Completely hydrolysed by boiling with dilute sulphuric acid; emulsin has no action. Dibenzalxylose has melting point 130°, $[\alpha]_D = +37·5°$ (in methyl alcohol), dibenzalrhamnose has melting point 128°, $[\alpha]_D = +56°$ (in methyl alcohol). Of the oily dibenzalhexoses, those derived from mannose, glucose, and galactose show a faint right-handed rotation, but the products obtained from fructose and sorbose are somewhat lævo-rotatory. Monobenzal-α-methylglucoside, melting point 158°, $[\alpha]_D = +85°$. Monobenzal-β-methylglucoside, melting point 194°, $[\alpha]_D = -75°$. Monobenzal-methylmannoside, melting point 110°, faintly lævo-rotatory. Dibenzal-methylmannoside, melting point 178°, $[\alpha]_D = -5°$. A. F.

1212. *Indicators in Acidimetry and Alkalimetry.* **W. Salessky.** (Zeitschr. Elektrochem. 10. pp. 204–208, March 25, 1904. From the Göttinger Institut für physikalische Chemie.)—In order to measure the sensitiveness of indicators, the author measures the potential difference between a hydrogen electrode and a solution containing the indicator at its transition tint. With very sensitive indicators, a small amount of a strongly dissociated salt (sodium nitrate) is added to the solution and also to the N-hydrochloric acid solution surrounding the other platinum electrode, in order to make the e.m.f. of the liquid element immeasurably small. Excepting in the cases of methyl orange and methyl violet, the sensitiveness of the indicators examined is practically independent of their concentration. The results obtained are as follows:—

Indicator	Tint.	Concentration of Hydrogen Ions (normal).
Methyl violet ...	Blue	1×10^{-3}
Benzopurpurin B	Violet	5×10^{-4}
Fluoresceïn	Strong diminution of fluorescence	$4{\cdot}2 \times 10^{-4}$
Galleïn	Red	$6{\cdot}3 \times 10^{-5}$
Congo red.........	Bluish-violet	$6{\cdot}0 \times 10^{-5}$
Rosolic acid	Red	$5{\cdot}4 \times 10^{-5}$
Alizarin	Red	$3{\cdot}6 \times 10^{-5}$
Turmeric	Yellow	$1{\cdot}4 \times 10^{-7}$
Phenolphthaleïn	Colourless	1×10^{-7}
„	Quite red	$3{\cdot}2 \times 10^{-9}$
Curcumin W......	Yellow	$4{\cdot}8 \times 10^{-8}$
Tropäolin OOO	Yellow	1×10^{-8}
Litmus	Red	1×10^{-5}
„	Blue	1×10^{-8}

The value given above for methyl violet is for a solution made almost opaque with indicator; if, however, the solution is scarcely coloured, the concentration of the hydrogen ions is 2×10^{-3} N. The numbers obtained for different concentrations of methyl orange are:—

Concentration of Indicator.	Tint.	Concentration of Hydrogen Ions.
1/20,000 — 1/50,000 N	Yellow	$1{\cdot}4 \times 10^{-5}$ N
1/60,000 — 1/100,000 N	„	$6{\cdot}8 \times 10^{-6}$ N
1/4,000 — 1/6,000 N	„	1×10^{-7} N

The indicators can be used for a rapid approximate estimation of the strength of weak acids and bases, as is shown for boric and carbonic acids Litmus is superior to phenolphthaleïn for indicating hydroxyl ions, the concentrations of these being in the two cases, 1×10^{-6} and 3×10^{-6} N.

T. H. P

1213. *Chemical Displacement during Coagulation.* **J. Duclaux.** (Comptes Rendus, 138. pp. 571–572, Feb. 29, 1904.)—The author has recently shown [see Abstract No. 929 (1904)] that colloids do not possess a simple invariable composition, but contain a larger or smaller amount—according to the constitution of the solution—of the negative or positive radicle of the salt used for coagulation. For example, copper ferrocyanide, prepared from potassium ferrocyanide and a cupric salt, always contains potassium, having the composition $FeCy_6Cu_mK_n$, where $2m + n = 4$; when its colloidal solution is precipitated by the salt of any metal, the latter is always found in the precipitate in which it replaces electrochemically equivalent proportions of copper or potassium, which is found in the supernatant liquid united with the acid of the salt. This method may be used for the analysis of such colloids as the above. In the particular case considered, a silver salt effects coagulation by replacing the copper, or an aluminium salt by replacing the potassium; the quantity of either of these metals in the supernatant liquid can then be determined. T. H. P.

1214. *Velocity of Reaction in Solutions containing Ferrous Sulphate, Potassium Iodide, and Chromic Acid.* **Miss C. C. Benson.** (Journ. Phys. Chem. 7. pp. 356–388, May, 1903.)—This paper is a sequel to a former paper by the author [see Abstract No. 1276 (1903)] and to one by De Lury (see Abstract No. 192 (1904)]. The results of the combined experiments lead to the following conclusions: The rate of liberation of iodine in the absence of ferrous salts is very nearly proportional to the concentration of the bichromate, and to the square of that of the acid, and is dependent on the concentration of the iodide according to an equation of the form $R = mC + nC^2$. The rate is accelerated by ferric salts. In the absence of iodides the rate of oxidation of ferrous sulphate is proportional to the square of the concentration of the ferrous salt and of the acid, and to the 1/4th to 1/8th power of the concentration of the bichromate. The rate is retarded by ferric salts. In the presence of ferrous salt the rate of liberation of iodine is proportional to the 1/3rd to 1/6th power of the concentration of the bichromate, to the fourth power of that of the acid, to the first power of that of the ferrous salt, and to the first (or a less) power of that of the iodide. The rate is retarded by ferric salts. In the presence of iodide the rate of oxidation of ferrous sulphate is proportional to the first power of the concentration of the ferrous salt, to the third or fourth power of that of the acid, and to the first power of the concentration of the bichromate. Increase of iodide first increases, then decreases the rate. The author does not think the results to be in accord with the peroxide theory, according to which the primary product of the oxidation of the ferrous salt is a peroxide which afterwards reacts with the iodide and with the residual ferrous sulphate, forming ferric salts and liberating iodine. Better, but still imperfect, agreement is obtained if the iodide is assumed to take part in the reaction. It is suggested that the primary reaction is between the ions, Cr_2O_7, FeI, I and 4H, and the further action between Cr_2O_7, 2Fe and 2H. D. H. J.

1215. *Solid Solutions and the Isomorphism of Halogen and Nitro-derivatives.* **G. Bruni** and **M. Padoa.** (Accad. Lincei, Atti, 12. pp. 348–355, May 3, 1903.)—The authors are engaged in an investigation of the morphotropic relations between chloro and nitro derivatives and between the nitrates and halides of quaternary bases. The impetus to the work was given by the discovery in crystallographic literature of a case of true isomorphism (not complicated by isodimorphism) between the nitrate and the bromide of nitro-phenyl trimethylammonium. The present paper gives the initial results. The cryoscopic method of testing the presence or absence of solid solutions was adopted. Some crystallographic data are added. The experiments were with solutions of chloro, of bromo, and of iodobenzene in benzene; *p*-chloronitrobenzene in *p*-dichlorobenzene; *p*-bromnitrobenzene in *p*-dibrombenzene; *p*-nitrotoluene in *p*-bromtoluene; *p*-nitrotoluene in *p*-iodotoluene; *α*-bromnaphthalene in *α*-nitronaphthalene; *β*-nitronaphthalene in *β*-chloro, in *β*-bromo, and in *β*-iodo naphthalene. From the data it appears that (1) by dissolving the nitro-derivative in the corresponding halogen compounds we have in general (with one exception) the formation of solid solutions, while, on the other hand, (2) we have little or no evidence of such formation of solid solutions when the halogen compounds are dissolved in the corresponding nitro bodies. It may be relevant to remark that the nitro compounds have higher melting-points than the halogen derivatives, and this would contribute to render the cryoscopic anomalies more marked in the first than in the second case. We may say, then, that the (NO_2) group should be added to Bruni's first series (I*a*) of isomorphogenous groups. D. H. J.

1216. *Velocity and Mechanism of the Reaction between Potassium Ferricyanide and Potassium Iodide in Neutral Aqueous Solution.* **F. G. Donnan** and **R. le Rossignol.** (Chem. Soc., Journ. 83. and 84. pp. 703–716, June, 1903.)—(1) The interaction is a reversible one, as represented by the equation $2KI + 3K_3Fe(CN)_6 \rightleftarrows 2K_4Fe(CN)_6 + I_2$. (2) The reaction between potassium ferricyanide and potassium iodide in neutral aqueous solution appears to be a quinquemolecular reaction, as the velocity of the reaction is represented by the equation $-\frac{dc_1}{dt} = kc_1^2c_2^3$, where c_1 = concentration of ferricyanide, c_2 = concentration of iodide. (3) The simplest interpretation of this result is that the reaction is represented by the equation—

$$2\overset{-}{\mathrm{Fe}}(\overset{-}{\mathrm{C}}\overset{-}{\mathrm{N}})_6 + 3\overset{-}{\mathrm{I}} = 2\overset{-}{\mathrm{F}}\overset{-}{\mathrm{e}}(\overset{-}{\mathrm{C}}\overset{-}{\mathrm{N}})_6 + \overset{-}{\mathrm{I}}_3.$$

(4) This view does not, however, explain all the observed results, as the variation of the velocity-coefficient with the total concentration, ferricyanide plus ferrocyanide. (5) If it is supposed that the reaction occurs between ferric and iodine ions according to the equation $2\overset{+++}{\mathrm{Fe}} + 3\overset{-}{\mathrm{I}} = 2\overset{++}{\mathrm{Fe}} + \overset{-}{\mathrm{I}}_3$, the ferric ions resulting from the dissociation of the complex ferricyanogen ions, this theory supplies a complete quantitative account of the observed results if the not improbable assumption is made that the ferro- and ferricyanogen complexes are of equal stability. T. M. L.

1217. *Changeable Hydrolytic Equilibrium of Dissolved Chromic Sulphate.* **T. W. Richards** and **F. Bonnet, Jr.** (Amer. Acad., Proc. 39. No. 1. pp. 3–30, June, 1903. Part of thesis presented by F. Bonnet at Harvard University.)—The authors have studied the nature of the violet and green solutions of chromium sulphate with the following result: From dialysis experiments they found that the violet chromic sulphate dialyses in normal atomic proportions, while green chromic sulphate allows an excess of sulphuric acid to pass through the diaphragm. This result indicates that the colour change is due to hydrolysis. Experiments were also made on the velocity of inversion of sugar. The green solution inverted the sugar rapidly, while the violet solution had only slight action; and the velocity was such that a N/4 molar solution contains as much ionised hydrogen as a 0·133 normal solution of hydrochloric acid. The extent and speed of the hydrolysis depend on the temperature. The acid formed by hydrolysis may be removed by successive shaking with a mixture of ether and alcohol, or by digestion with chromic hydroxide. Excess of acid accelerates the reversion to violet, and retards the formation of the green salt. The formation of green sulphate requires time, either from the double decomposition of the green chloride or from hydrolytic action. The ratios of $Cr : SO_4$ in a solution saturated with chromic hydroxide is at 100°, $Cr : (SO_4)$ and at 20°, $Cr_5 : (SO_4)_4$. From experiments on the ionic migration, the authors conclude that there is no anion containing chromium in the green solution. They consider that all their experiments point to the existence of a green basic salt in which at least 47 per cent. of the acid radicle is replaced by hydroxyl, and that it is possible there may be several compounds of different degrees of hydrolysis, the acid set free being sulphuric acid and not a complex acid. A bibliography is appended. **A. F.**

1218. *Solubility of Hydrated Sulphate of Lime in Solutions of Sea Salt.* **A. d'Anselme.** (Chem. News, 89. pp. 9–10, Jan. 1, 1904.)—The following table shows the solubility of calcium sulphate in water containing different proportions of sodium chloride. It will be noticed that the solubility reaches a maximum at about 130 gm. NaCl per litre, and that in solutions charged with salt the solubility varies but little with the temperature.

NaCl, per litre.		Anhydrous SO_4Ca dissolved, per litre.	
Gm.	Molecule.	At 14°.	At 20°.
0	N/∞	1·70	2·10
2·925	N/20	2·32	2·70
5·850	N/10	2·79	3·15
11·70	N/5	3·41	3·75
14·62	N/4	3·68	4·00
29·25	N/2	4·40	4·70
58·50	N	5·72	6·00
87·75	0·5 N	6·58	6·85
102·3	0·75N	6·90	7·15
117·0	2 N	7·10	7·30
131·6	2·25N	7·20 (max.) ……	7·30 (max.)
146·2	2·5 N	7·10	7·13
160·8	2·75N	7·00	7·05
175·6	3 N	6·80	6·80
204·7	3·5 N	6·30	6·30
234·0	4 N	5·90	5·90
263·2	4·5 N	5·50	5·52
292·6	5 N	5·30	5·30

T. M. L.

1219. *Solubility and Diffusion in Solution of Dissociated Gases.* **O. W. Richardson.** (Phil. Mag. 7. pp. 266–274, March, 1904.)—A theoretical treatment of the case when each molecule dissociates into *n* similar molecules. Henry's law is assumed and the work done in a reversible cycle obtained, when the pressure of the dissociated gas is a small fraction of the total. Also the temperature coefficient of the solubility depends directly on the heats of solution of the constituents. The author finds that the rate of diffusion through an infinite slab can be expressed by two terms, proportional to the pressure and its *n*th root respectively. However, when the gas combines with the solvent there is a discontinuity at the dissociation pressure. **H. H. F. H.**

1220. *Action of Metallic Magnesium upon Aqueous Solutions.* **L. Kahlenberg.** (Chem. News, 88. pp. 312–316, Dec. 24, 1903. Paper read at the Washington Meeting of the Amer. Chem. Soc., and at the Meeting of the Wisconsin Academy, Dec. 26, 1902. From the Journ. Amer. Chem. Soc., 25, No. 4.)—The following table shows the rate at which hydrogen is liberated from various aqueous solutions. The figures represent the number of c.cm. of gas liberated from a bar of magnesium of 1,200 sq. mm. surface in the given times at about 20° C.—

Time (hours)	2·5.	23·5.	47·5.	53.
Distilled water	0·02	0·10	1·5	1·8
Alcohol (2 gm. mols. per litre)	0·10	0·40	7·6	7·8
Glycerol (2 „ „)	0·01	0·05	0·5	0·55
Cane-sugar (2 „ „)	0·10	0·65	1·0	1·2
Mannitol (1 „ „)	0·08	0·20	0·4	0·55
Urea (2 „ „)	1·2	10·6	29·0	31·0
Sodium chloride (2 gm. mols. per litre)	7·4	49·8	—	—
Sodium sulphate (1 „ „)	2·4	9·9	18·0	18·8

Glycerol produces a retardation throughout, and cane-sugar and mannitol in the later stages of the action. The accelerating effect of the alcohol is very marked. Urea liberated ammonia as well as hydrogen. Magnesium salts are especially active, the chloride acting almost as rapidly as an acid (see especially the values for N/100 solutions), although the corresponding chlorides of calcium, strontium, and barium are almost inert. This is shown by the following table—

	1 gm. mol per litre.		1/10 gm. mol. per litre.		1/100 gm. mol. per litre.		
	25 min.	95 min.	25 min.	4 hrs. 5 m.	31 min.	5 h. 25 m.	22 h. 49 m.
$MgCl_2$	13·0	33·8	10·8	47·6	3·2	20·0	43·0
$MgBr_2$	4·8	14·8	1·8	8·6	2·0	9·6	20·9
$MgSO_4$	5·9	21·5	1·8	8·6	2·4	11·6	29·6
$Mg(NO_3)_2$	0·2	0·65	0·2	1·8	—	—	—

	17 min.	49 min.
KCl	11·5	24·0
KCl + $MgCl_2$	15·0	31·4

	2 min.	11 min.	28 min.	46 min.
H_2SO_4 (N/10)	3·2	21·0	37·6	45·6

	1 min.	11 min.	29 min.	49 min.
HCl N/10	3·0	27·5	43·5	48·8

	5 min.	20 min.	30 min.	3 h. 37 min.
H_2SO_4 N/100	0·4	2·5	3·6	14·3
HCl N/100	0·4	2·5	3·6	11·8

In many cases magnesium amalgam is acted on when the pure metal is unattached.

T. M. L.

1221. *Association of Solute Determined by Tyndal's Optical Method.* **C. A. L. de Bruyn** and **L. K. Wolff.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 778–786, March, 1904.)—A discussion of some recent work on colloidal solutions, especially of gold. Inorganic salt solutions are quite transparent with Dubos lamp, but sugars, &c., give slightly diffusive solutions, emitting polarised light. The authors hold that there is continuity between different kinds of solution.

H. H. F. H.

1222. *Lead-Tin Alloys.* **O. Sackur.** (Arb. a. d. kaiserl. Gesundheitsamte, 20. p. 512, 1903. Chem.-Zeit. 28. Rep. 33, 1904. Soc. Chem. Ind., Journ. 23. p. 255, March 15, 1904. Abstract.)—A state of equilibrium is attained when the salts of the two metals are present in certain concentrations in hydrochloric acid solution. These concentrations were determined at 18° and 25° C. with solutions containing various amounts of free acid. The amount of stannous chloride in solution was found to be a linear function of the amount of lead chloride, in agreement with Nernst's theory and the law of mass action. The apparently contradictory phenomena observed in the precipitation of these two metals from different solutions are considered to be due to lead's possessing a greater electrolytic solution pressure, and that stannous chloride and tin acetate are only very slightly dissociated, with production of free tin ions. L. H. W.

1223. *Reaction Velocity in Heterogeneous Systems.* **E. Brunner.** (Zeitschr. Phys. Chem. 47. pp. 56–102, Jan., 1904. Extract of Göttinger Dissertation, 1903.)—The author has studied the velocity of solution of benzoic acid in water, metallic oxides (magnesia) in various acids, of metals (magnesium) in acids, of the electrolytic separation of hydrogen from acids, of electrolytic reduction of iodine solutions, and of the solubility of solid iodine, and has obtained results which confirm a theory put forward by Nernst. According to this theory, equilibrium always exists in the interface between two interacting phases; the chemical processes proper take place in this layer, and if they take place sufficiently rapidly the velocity of reaction is determined only by the velocity with which the differences of concentration are equalised by diffusion. The chief results obtained by the author are the following: (1) In all cases investigated, the velocity of reaction was exactly or very approximately proportional to the two-third power of the velocity of stirring. Whether, in spite of the stirring, the evolution of gas has any influence, could not be ascertained. (2) The velocity of reaction does not depend on the true extent of the surface, but on the quadratic dimensions, and increases only when the unevenness of the surface becomes very great. In some cases, however, the nature of the surface has undoubtedly an influence, not due to its roughness. (3) With equal velocity of stirring, the thickness of the diffusion layer depends on the arrangement; the thickness also diminishes with rise of temperature, in accordance with the diminution of the internal friction of the solution. (4) The velocity of a reaction in which a dissolved substance is used up, which is not capable of existing in appreciable concentration at the surface of the solid body, is, in accordance with the theory, proportional to the concentration of the reacting substance, when its coefficient of diffusion is constant, so that $A = v/\Delta t \log c_1/c_2$, where c_1 and c_2 are the concentrations of two successive samples and Δt the interval of time between the taking of these. V is the volume actually present during this interval. The constant A is equal to (surface × coeff. of diffusion)/(2·3026 × thickness of diffusion layer). (5) The nature of the solid body can have no influence on the velocity of reaction if only the concentration of the diffusing substance is practically zero. This was confirmed in the following cases: In benzoic acid, basic magnesium carbonate and metallic magnesium dissolve about as quickly as magnesia; calcium hydroxide, however, considerably quicker. This follows according to theory, from the considerable solubility of the last. In hydrochloric acid, magnesium dissolved as quickly as magnesia, but marble about 40 per cent. more rapidly. (6) The velocity of electrolytic separation of hydrogen at a platinised platinum kathode from solutions of benzoic acid and hydrochloric acid containing large excess of potassium chloride was found within certain limits of the cathode potential independent of the latter and equal to the velocity of solution of magnesia. This follows from the fact that with the potential employed, the concentration of the acid at the cathode is kept at a practically vanishing value. From the equation given above, $A = (v/\Delta t) \log c_1/c_2$, it follows that the velocity of a chemical reaction can be referred to a physical process. A. F.

1224. *Standard Electrodes.* **L. Sauer.** (Zeitschr. Phys. Chem. 47. pp. 146–184, Feb., 1904. Physikalisch-chemisches Institut, Leipzig, Jan., 1903.)—The author has investigated various standard electrodes with a view to ascertaining their constancy, reproducibility, influence of purity of material and concentration of solutions, age, illumination, temperature, &c. The first electrode investigated was Hg-HgCl | norm.-KCl. This was prepared in two ways. (1) The solution of KCl was shaken with calomel and mercury before use, and the mercury and vessel employed washed with the solution. Electrodes prepared in this way showed immediately after preparation differences of as much as 1·5 millivolt, but became constant after 5–6 hours. (2) The mercury and calomel were shaken with the solution of KCl so that a paste was formed, the calomel being first purified by washing with potassium chloride. Such electrodes agreed with one another within the limits of experiment (0·1 millivolt) immediately after preparation, and they were also very sensitive to shock. With regard to the influence of impurities, it was found that the mercury could be sufficiently purified by shaking twice with a dilute nitric acid solution of mercurous nitrate. In the case of the potassium chloride, the impurities present in the ordinary salt can cause considerable variations in the potential. The preparation "Kahlbaum" can be employed directly, but the ordinary salt must be purified by twice precipitating from aqueous solution with alcohol. Less care need be taken with the calomel, it being sufficient (in the case of Kahlbaum's calomel) to decant once with a solution of potassium chloride. The effect of fineness of subdivision was also tested and the greater solubility of finely divided calomel shown. The results of the e.m.f. measurements are given below :—

Electrode.	Reproducibility.	Electrode.	Reproducibility.
Hg-HgCl | n-KCl	0·1 millivolt	Hg-HgCl | $\frac{n}{10}$-HCl	Ca · 2·0 millivolt
Hg-HgCl | $\frac{n}{10}$-KCl	0·2 "	Hg-Hg_2SO_4 | n-H_2SO_4	0·1 "
Hg-HgCl | n-HCl	0·1 "	Hg-Hg_2SO_4 | $\frac{n}{10}$-H_2SO_4	0·1 "

The different electrodes were compared, the e.m.f. of the calomel electrode with n-KCl being taken = 0·560 volt at 18°. The following values (in volts) were found :—

$$\pi(\mathrm{Hg}) - \pi(\tfrac{n}{10}\text{-KCl}) = +\,0{\cdot}612 \qquad - \pi(\tfrac{n}{10}\text{-HCl}) = +\,0{\cdot}611$$

$$- \pi(n\text{-HCl}) = +\,0{\cdot}554 \qquad - \pi(n\text{-H}_2\text{SO}_4 = +0{\cdot}962 + 0{\cdot}0011(t-18).$$

A. F.

1225. *Mixtures of Antimony Trisulphide and Antimony.* **H. Pélabon.** (Comptes Rendus, 138. pp. 277–279, Feb. 1, 1904.)—When melted, a mixture of antimony with its trisulphide generally yields, not a homogeneous liquid, but two liquids, the upper one being a solution of antimony in liquid antimony trisulphide and the lower one a mixture of antimony with a small proportion of the trisulphide. If, however, the ratio of the sulphur present to the total mass of the mixture is less than 0·015 or greater than 0·25, a single homogeneous liquid is obtained. The author finds that pure antimony solidifies at 632°, the saturated solution of the trisulphide in antimony at 615°, the trisulphide at 555°, and the saturated solution of antimony in the trisulphide at 515°. This solution solidifying at 515° cannot be regarded as antimony monosulphide, as the proportion of sulphur present is 0·25 instead of the required 0·21. T. H. P.

1226. *Inversion of Sugar.* **L. Lindet.** (Comptes Rendus, 138. pp. 508–510, Feb. 22, 1904.)—The author gives the results of an investigation into the conditions under which sugar is inverted by water, a 10 per cent. sugar solution being heated in a boiling-water bath for 4 hours in each experiment. The varying acidities of the different sugars is shown by the conductivities of their solutions. Taking the conductivity of water as 1, the value for saccharose is 1·3, for levulose 3·7, and for dextrose 5·1. The addition to saccharose of $\frac{1}{3000}$ part of invert sugar doubles the amount of inversion. If the vessel in which the inversion takes place is of glass, especially white glass, the solution extracts so much alkaline silicate from it that the slight acidity of the liquid is neutralised and the inversion retarded or even prevented. If in one and the same flask fresh sugar solutions are successively boiled, the proportion of invert formed rises from 1 to 5 and then remains constant. If, however, the flask is previously heated with water or dilute acids, the maximum inversion is obtained at once. If a metal vessel is employed in place of glass, the amount of invert sugar formed varies from 1 to 20, according to the nature of the metal. If the metal is added to the sugar solution as grains or turnings, considerable increase in the inversion takes place with copper, lead, tin, or bismuth, slight increase with aluminium or antimony, retardation with cobalt, iron, zinc, cadmium or magnesium, while nickel, chromium, arsenic, gold, platinum, silver, and mercury are without influence. This varying action of the metals depends partly on the formation or non-formation of hydroxides and partly (with copper) on the formation of a trace of acid, probably by reduction of the sugar. The influence of the formation of hydroxide on the inversion is confirmed by the fact that on boiling in metal vessels a sugar solution containing air, the inversion is much greater than with a sugar solution previously freed from air. The action of the metals in increasing inversion is the greater—(1) the lower the heats of formation of its compounds, (2) the greater the tendency of these compounds to decompose chemically, (3) the less the readiness with which the compounds dissociate in aqueous solution, (4) the less the heat development on ionisation, and (5) the smaller the electrolytic solution-tension. T. H. P.

1227. *Transformation of Sodium Isonitrosoacetophenone into Sodium Benzoate and Hydrogen Cyanide.* **C. H. Sluiter.** (Konink. Akad. Wetensch. Amsterdam, Versl. 12. pp. 453–456, Feb. 25, 1904. Translated from Versl. van de gewone vergadering der Wis- en Natuurkundige Afdeeling, Jan. 30, 1904. Org. Chem. Lab. d. Univ. Amsterdam, Dec., 1903.)—The substance $C_6H_5\cdot CO\cdot CH:NONa$ undergoes change into $C_6H_5\cdot COONa$ and HCN, and the author has investigated the velocity of the reaction. The reaction velocity was followed colorimetrically, the aqueous solution of the sodium salt being yellow, and that of the decomposition products being colourless.

The reaction is monomolecular. For a 1 per cent. solution at 53·6°, $k = 0{\cdot}00062$, for a 5 per cent. solution, $k = 0{\cdot}00049$. For a 1 per cent. solution at 60°·1, $k = 0{\cdot}0023$; at 70°, $k = 0{\cdot}0048$. Addition of NaCl or NaOH retards the reaction, but if a large excess of NaOH is added the velocity of decomposition is the same as for pure water. The velocity of decomposition in methyl and ethyl alcohol solution was also determined. For a 1 per cent. solution (at 60°) in water, $k = 0{\cdot}0023$, in absolute methyl alcohol, $k = 0{\cdot}0017$; in 97 per cent. methyl alcohol, $k = 0{\cdot}0018$; for a 0·5 per cent. solution in 97 per cent. ethyl alcohol, $k = 0{\cdot}001$; for 50 per cent. ethyl alcohol, $k = 0{\cdot}0013$.

A. F.

1228. *Solubility of Silicon in Zinc and Lead.* **H. Moissan** and **F. Siemens.** (Comptes Rendus, 138. pp. 657–661, March 14, 1904.)—The authors have investigated the solubility of silicon in lead and zinc by heating an excess of pure silicon with either of the pure metals in an electric furnace, the temperature being observed by means of a Chatelier pyrometer. Two hours were long enough to obtain a saturated solution, but in all cases the mixture was heated up for three hours. The solubility of silicon in lead is given by the following table :—

Temperature, °C.	1250	1330	1400	1450	1550
Per cent. of silicon dissolved ...	0·024	0·070	0·150	0·210	0·780

Below a temperature of 1,100° C. solution does not take place. The silicon was obtained in the form of yellowish-brown crystals after dissolving the lead in nitric acid and treating the residue with cold hydrofluoric acid in order to remove any traces of silicates which may have been formed. Zinc has a much greater solvent action on silicon, as shown by the following figures :—

Temperature, °C.	600	650	730	800	850
Per cent of silicon dissolved	0·06	0·15	0·57	0·92	1·62

Concordant observations could not be obtained above 850° C. T. S. P.

1229. *Potential Differences with Saturated Solutions.* **D. McIntosh.** (Journ. Phys. Chem. 7. pp. 348–355, May, 1903.)—It has been proved thermodynamically by Luther [Zeitschr. Phys. Chem. 19. p. 529 (1896)] that changing the solvent at one electrode should have no effect on the e.m.f. in a two-solution cell if the solutions were already saturated with respect to the electrolyte. It was shown later that this only holds when the cell has an anhydrous salt as solid phase. The author's investigations in this direction were made with cells consisting, on the one hand, of saturated solutions of certain salts in water or ethyl or methyl alcohol, and, on the other, of saturated solutions of the same salts in definite mixtures of alcohol and water. The salts employed are: $HgCl + KCl$ (with mercury electrodes), $AgNO_3$ (silver electrodes), $CdCl_2$ (mercury electrodes), $PbCl_2$ (lead electrodes). It is found that the e.m.f. in cells of this type is not zero, and that it is due to the saturated solutions not being in equilibrium. It is, however, not possible to predict the sign or value of the e.m.f. from any property of the components. In the author's opinion the mistake in the above reasoning, which indicates that the e.m.f. should be zero, lies in the assumption of the law "if two systems are in equilibrium with a third they are in equilibrium with one another," which only holds for non-miscible phases. T. H. P

1230. *Separation and Estimation of Antimony by the Electrolytic Method.* **A. Hollard.** (Chem. News, 87. pp. 282–283, June 12, 1903. Bull. Soc. Chim., Series 3, vol. 29. p. 262.)—The electrolytic estimation of antimony in solution in sodium sulphydrate is open to certain objections which the author summarises. The modification of the method proposed by the author is as follows: The antimony in the state of sulphide, or as oxide made slightly alkaline by the addition of soda, is dissolved in a mixture of 200 c.cm. of saturated sodium sulphydrate (density 1·220 to 1·225) and 40 c.cm. of a 20 per cent. aqueous solution of potassium cyanide. The electrodes are plunged completely into this solution, which occupies a volume of 240 c.cm. The kathode employed was of platinum gauze in the form of a truncated cone. The presence of tin does not interfere with the reaction provided there is not more than 1 gm. present; neither does the presence of copper matter so long as there is not more than 0·05 gm. present. The presence of arsenic does not exercise any influence when present in the pentavalent condition. A. F.

1231. *Constitution of the Electrolytic Peroxides of Lead, Nickel, and Bismuth.* **A. Hollard.** (Chem. News, 87. pp. 283–284, June 12, 1903. Bull. Soc. Chim., Series 3, vol. 29, No. 4.)—Contrary to what has hitherto been held, the deposit on the anode obtained by electrolysis of solutions of lead salts contains more oxygen than corresponds to the composition PbO_2, showing that the deposit contains some higher superoxides. The author has also found, on varying the concentration of the solutions, that the proportion of the superoxides is the greater the lower the concentration of lead in the bath. Nickel, in alkaline solution of pyrophosphate, treated with chromic acid, gave a peroxide—with a concentration of 0·05 gm. of nickel per 300 c.cm., the bath being at a temperature of 70°—which corresponded to the composition NiO_4. Bismuth gave a deposit at the anode which, dried at 130°, had a composition Bi_2O_7 in a concentration of 0·05 gm. of bismuth per 300 c.cm. of the bath. The bismuth was in the form of sulphate in the presence of 20 c.cm. of nitric acid at 36° in excess, and 40 gm. of hydrated copper sulphate for a volume of 350 c.cm. of bath. A. F.

1232. *Electrochemical Behaviour of Radium.* **A. Coehn.** (Ber. Deut. Chem. Gesell. 37. pp. 811–816, 1904.)—From the thermochemical data it would appear that the separation of the metal would be increasingly difficult in the series Ca, Sr, Ba, but when a mercury kathode is used the voltage required is greatly reduced owing to the energy liberated in the formation of an amalgam, and the order in which the metals separate is reversed. Thus it requires 0·2 volt more to separate strontium from barium, and 0·25 volt more to separate calcium than strontium; if the series were continued, radium should require less voltage than barium by considerably more than 0·25 volt, and it is actually found that metallic radium is precipitated by barium amalgam. Owing to the very small proportion of radium in the crude bromide it is impossible to effect a sharp separation of the metals except at an impracticably small current-density, but a considerable concentration may be effected by this method. It is of interest to note that freshly-prepared (unoxidised) radium amalgam, like the salts of the metal, only slowly attains its maximum activity, whilst the (silver) anode, which appears to attract to itself the greater part of the excited activity and is at first more radio-active than the kathode, soon becomes altogether inactive. T. M L.

1233. *Electrolysis with Alternating Currents.* **M. le Blanc** and **K. Schick.** (Zeitschr. Phys. Chem. 46. pp. 213–243, 1903. Communication from the Institut f. physikal. Chemie u. Elektrochemie der techn. Hochschule, Karlsruhe.)—A rotatory commutator was used to produce alternating currents of different frequencies. The following tables show how the frequency affects (1) the dissolution of metallic electrodes in sodium acetate solutions, and (2) the conversion of the electrodes into insoluble sulphides by immersion in sodium thiosulphate. I. Electrolyte 2N $NaC_2H_3O_2$; current density, 4·61 amperes per sq. dcm. Time, 15 min.

Alternations per min.	Percentage Loss in Weight of Electrodes.	
	Cadmium.	Zinc.
1	92	91·5
5	83	90
10	63	61
66	—	34
90	32	—
140	—	17
250	23	—
512	—	10
1060	—	7·5
1280	4·5	—
3550	—	3
5800	2·5	—
6900	2·0	1·6
9600	1·4	—

II. Electrolyte 2N $Na_2S_2O_3$; current density, 4·61 amperes per sq. dcm. Time, 15 min. Vigorous stirring with hydrogen.

Alternations per min.	Yield per cent. of		
	CdS.	ZnS.	AgS.
0	100	100	100
1	77	84	59
5	47	43	23
10	38	46	13
12	34	—	—
60	22	—	4
90	15	—	4
100	—	24	—
250	10	—	3
1280	2	—	1
1500	—	2	—
4800	0	—	0
6900	0	2	—
9600	0	—	—

The following table shows the influence of current density on the dissolution of copper in potassium cyanide at different frequencies.

III. Copper electrodes in 4N KCN. Time, 15 min.

Alternations per min.	Current Density.		
	10·0 ampere $dcm.^2$.	4·62 ampere $dcm.^2$.	0·62 ampere $dcm.^2$.
	Yield.	Yield.	Yield.
72	100 per cent.	100 per cent.	—
112	—	—	100 per cent.
688	—	99·4	—
1400	—	—	90·0
3300	—	—	73·0
3420	—	91·0	—
6100	84·2	—	—
7050	91·4	—	—
8000	—	—	42·1
9140	—	77·7	—
10300	—	—	32
15200	82·2	—	—
16000	—	—	16
17600	—	58·6	—
24000	—	—	12·1
27200	—	43·8	—
31200	65·5	—	—
36800	—	—	7·1
38600	—	33·6	—

The following table shows the influence of concentration of the electrolyte on the dissolution of the electrodes at different frequencies. **IV. Copper electrodes in KCN. Current density, 4·61 amperes per sq. dcm.**

Alternations per min.	4N KCN.	N KCN.	N/10 KCN.
	Yield.	Yield.	Yield.
72	100 per cent.	— per cent.	— per cent.
112	—	99·0	28·2
500	—	94·9	—
520	—	—	27·8
688	99·4	—	—
2230	—	83·1	—
2520	—	—	26·0
3420	91·0	—	—
3920	—	74·8	—
6100	84·2	—	—
6740	—	62·1	—
8730	—	—	27·9
9140	77·7	—	—
10240	—	48·0	—
11200	—	—	22·1
14850	—	30·2	—
16000	—	—	18
17600	58·6	—	—
19200	—	17·1	17
24000	—	10·4	—
26400	—	—	15·5
27200	43·8	—	—
35200	—	—	10·1
38400	—	4·9	—
38600	33·6	—	—

Similar tables are given for the dissolution of zinc, nickel, and silver in potassium cyanide under different conditions, and for the dissolution of copper in 2N $NaHSO_4$, of nickel in 50 per cent. H_2SO_4 and saturated KCl. The general result is that the yield decreases (1) as the frequency increases, (2) as the concentration decreases, and (3) as the temperature decreases, but the results vary greatly in the different cases studied. It may, however, be noted that the cyanide solutions give much larger yields than the sulphate or acetate solutions, so that whilst the yield in the latter cases falls almost to zero at a few hundred alternations per min., in the former case considerable yields can be obtained in strong solutions even at a frequency of 40,000. This is explained by supposing that the metal is converted immediately after dissolution into a complex salt, such as $K_2Ag(CN)_4$, in which it forms part of the acidic radicle and is driven by the reversal of the current away from the electrode instead of being redeposited upon it as would be the case if it remained still as a basic radicle or kation. T. M. L.

1234. *Alternating-current Electrolysis.* **A. Brochet** and **J. Petit.** (Comptes Rendus, 138. pp. 359–361, Feb. 8, 1904.)—The action studied was the dissolution of copper in potassium cyanide—

$$2Cu + 8KCN + 2H_2O = Cu_2(CN)_2, 6KCN + 2KOH + H_2.$$

This has been previously examined by le Blanc and Schick [see preceding Abstract], who employed a reversing arrangement, and was now studied whilst employing an approximately sinusoidal current of frequency 42 from the street mains. The results obtained were similar to those of le Blanc and Schick, and the yield of cyanide was well maintained until the solution was almost saturated with copper cyanide, after which the copper plates became covered with a reddish deposit of unknown composition [? cuprous cyanide]. Zinc and nickel behave in a similar manner and give double cyanides, but lead, silver, mercury, and cadmium are not appreciably attacked. T. M. L.

1235. *Liquid Hydrogen Chloride as an Electrolytic Solvent.* **D. Helbig** and **G. Fausti.** (Accad. Lincei, Atti, 13. pp. 30–37, Jan. 3, 1904.)—The results of the authors' experiments on carefully purified, liquefied hydrogen chloride are as follows: At its boiling-point and under the ordinary pressure liquid hydrogen chloride has the specific conductivity $0{\cdot}167 \times 10^{-6}$, a value similar to that obtained by Kohlrausch for highly-purified water. The chlorides of potassium, lithium, ammonium, copper (cuprous and cupric), lead, platinum, gold, and antimony are quite insoluble in liquid hydrogen chloride, which, however, dissolves stannic chloride, giving a solution having exactly the same electrical conductivity as the pure solvent. A lump of ice at the temperature of liquid air, when dropped on to liquid hydrogen chloride, floats unaltered on the surface, and remains there even though the temperature be raised so as to make the liquid boil; the conductivity of the latter meanwhile undergoes no change. T. H. P.

1236. *Influence of the Physical Nature of the Anode on the Constitution of Lead Peroxide. Application to Analysis.* **A. Hollard.** (Comptes Rendus, 138. pp. 142–144, Jan. 18, 1904.)—The ratio of metallic lead taken to lead peroxide deposited on the anode should be 0·866. Experiments with platinised platinum gave values ranging from 0·740 to 0·861 as the concentration of the lead solution was increased from 0·01 to 10 gm. per 300 c.cm.

When the electrodes were merely roughened by a sand-blast a much more constant ratio was obtained, the average being 0·853 in the case of a solution of lead in an excess of nitric acid, and in the case of solutions of lead sulphate in a mixture of ammonium nitrate and nitric acid. This is attributed to the formation of a higher oxide than PbO_2, but the evidence given is somewhat scanty. In estimating lead as peroxide by electrolysis, it is advisable to work with a rough platinum anode and use the factor 0·853, as with a platinised anode it would be necessary to use a factor depending on the concentration.

T. M. L.

1237. *Tungsten Compounds.* **E. Schaefer.** (Zeitschr. Anorg. Chem. 38. 2. pp. 142–183, Jan. 18, 1904.)—The author has prepared a number of tungsten bronzes and has also studied the behaviour of some of them on electrolysis. The solutions were electrolysed between platinum electrodes, and the anode and kathode liquids were separated by a porous pot. Electrolysis of sodium and potassium tungstate solutions with a current density of about 3–6 amperes per 100 sq. cm. on the anode, gave good yields of the paratungstate, and on continuing to pass the current longer, the metatungstate and then tungstic acid separated out. In the case of ammonium tungstate the paratungstate quickly separated out in large quantities. The preparation of the ammonium metatungstate was unsuccessful. A. F.

1238. *Electrolytic Preparation of Periodic Acid and its Salts.* **E. Müller.** (Zeitschr. Elektrochem. 10. pp. 49–68, Jan. 22, 1904. From the electrochemical laboratory of the Königl. Sächs. Technische Hochschule, Dresden.) —The author has made an extended investigation of the conditions of the formation of periodates by electrolytic oxidation, in order to clear up many of the difficulties, but the results obtained show that before a complete explanation can be given a number of phenomena will have to be more fully studied. The good yields of periodate obtained in an alkaline solution, as compared with those from neutral or acid solutions, and using blank electrodes, are probably to be ascribed to the greater supertension at the platinum anode in alkaline solution. The yield is diminished with increase of temperature because the supertension is diminished. The yield of periodate in alkaline iodate solutions gradually increases with the time when certain current strengths are used; this is explained by the supertension increasing as the time of polarisation increases. Anodes of lead peroxide give very good yields of periodate; this is probably not due to an increased supertension, but to the catalytic influence of the peroxide itself, as it was shown that the latter will oxidise iodic acid to periodic acid by purely chemical means. The author has also made experiments on the effect of indifferent ions, such as SO_4'' and ClO_3', which bring about the formation of periodate even in neutral solution, but so far can give no satisfactory explanation of the results obtained. A convenient method for the electrolytic preparation of periodates is described. T. S. P.

1239. *Experimental Law of the Electric Transference of Dissolved Salts.* **A. Ponsot.** (Comptes Rendus, 138. pp. 192–194, Jan. 25, 1904.)—From the experimental results of an investigation made in 1890 by Chassy on the electric transport of dissolved salts, the following laws are derived: (1) In the electrolysis of a mixture of salts of the same acid, of which one is electrolysed, the total number of molecules transported depends only on the nature and concentration of this electrolysed salt, and is independent of the presence of the non-electrolysed salts. (2) When two salts are electrolysed, the total number of molecules transported depends on the nature of the salts, on their concentration, and on the fractional equivalent of each of them which is electrolysed, but is independent of other salts of the same acid present. These conclusions are not in accord with the present ionic theories, and are opposed to the hypotheses on which Kohlrausch bases the connection between the molecular conductivity of solutions and the transport numbers.

T. H. P.

1240. *Electrolysis of Chloric Acid and Chlorates.* **A. Brochet.** (Comptes Rendus, 138. pp. 200–208, Jan. 25, 1904.)—The author has confirmed the fact, noticed by Bancroft and studied by Burrows, that in the electrolysis of the chlorates of potassium, sodium, and barium with a copper anode, copper dissolves off the anode at a greater rate than it is deposited on the kathode of a voltameter in series, although no cuprous salts can be subsequently detected in the electrolyte. He shows that this is due to the fact that some of the copper leaves the anode in a cuprous state, but the cuprous salts so formed are immediately rendered cupric by the oxidising action of the chlorate in the electrolyte. J. D. C.

1241. *Electrolytic Separation of Metals.* **A. Hollard.** (Electro-Chemist, 3. pp. 402–410, Jan.; Discussion, p. 500, Feb., 1904. Paper read before the Faraday Society, Feb. 2, 1904.)—The principle of successive electrolytic separation of metals from a mixed electrolyte by gradually increasing the p.d. of the cell, is only applicable in practice to metals whose polarisation potentials are smaller than that of hydrogen. Three principles are applied to obviating this limitation: (1) The reduction of the resistance of the bath, by suppressing the gas formed at the anode. (2) The influence of the nature of the kathode on the polarisation potential of hydrogen. (3) The formation of complex salts. Two methods of applying (1) are given. The first is described in Abstract No. 687 (1904), and the second in Abstract No. 1512 (1903). The second principle depends upon the fact, shown by Caspari [see Abstracts Nos. 1941 (1899) and 257 (1900)], that the polarisation potential of hydrogen varies with the kathode metal at which it is liberated. Thus cadmium and zinc cannot be separated with platinum electrodes, for their polarisation potentials are respectively 0·43 and 0·77 volt greater than that of hydrogen, which is therefore liberated first. If, however, a cadmium kathode is used, the polarisation potential of hydrogen is raised by 0·68 volt, and consequently lies between those of cadmium and zinc. The cadmium may then be completely deposited, even in strongly acid solutions, without the liberation of hydrogen, and should the e.m.f. be raised, the disengagement of hydrogen so caused will prevent the deposition of the zinc. Experimental results are given for the above case. The third principle is applied by bringing the metal which is to remain in the electrolyte into the state of a complex salt, which dissociates to give, not metallic ions but complex ions containing the metal; so that the latter is only deposited by an e.m.f. greater than that necessary for the simple salt. In the *discussion,* **T. M. Lowry**, referring to the backward migration of the metallic ions described by the author, mentioned that Hittorf's recent researches showed that whereas animal membranes caused a marked transference of the metal into the anode compartment, this did not take place with a porous cell or silk gauze; one of these latter might therefore be used instead of parchment in the author's cell. J. D. C.